May, 1977 Price, \$2.00 Also in this issue:

Politics in Urban Transportation Converting Sunlight by Chemistry The Promise of the Space Factory

# Technology Review

600,000 GALLONS of Highlevel RADIDACTIVE WASTE LIE IN A TANK AT WEST VALLEY, NY. THE TANK WILL EVENTUALLY CORRODE. WHAT SHOULD BE DONE? WHO SHOULD

# technology review

Published by MIT

This PDF is for your personal, non-commercial use only.

Distribution and use of this material are governed by copyright law.

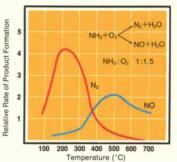
For non-personal use, or to order multiple copies please email permissions@technologyreview.com.

Why does ammonia on a platinum catalyst oxidize to nitric oxide one time and nitrogen gas another? Where do reactions take place on a platinum catalyst? What can be done to make catalysts live longer in an automotive catalytic converter?

Finding answers to these and other questions has been the object of a broad program by the Research Laboratories at General Motors.

For instance, we've learned that it may be

possible to select the product of oxidation of ammonia on a platinum catalyst: either nitric oxide or the desired nitrogen gas. How? By raising or lowering the temperature.



What's more, by creating terraces 12 atoms wide by 1 atom high on a single crystal platinum surface, we've been able to determine the "active site" of this reaction. It's the atom at the step from one terrace to another.

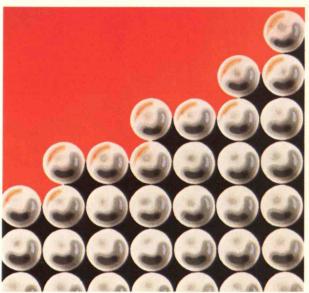
For us, this information is a stride toward our goal of an effective catalytic converter to reduce NO<sub>x</sub> emissions. For others, it may be a step in directions we had never considered, such as improved catalytic processes for making nitric acid or agricultural fertilizers.



In another phase of our catalysis research, we've studied the life span of a catalyst pellet in the chemically demanding environment of automotive exhaust gas. And from that, a mathematical model has been developed that points the way to future generations of longer living catalyst pellets.

At the Laboratories, we're reacting to make catalysts even more effective in reducing automotive emissions.

# Where the (re)action is. Our discoveries about catalysts could help put food on your table.





# **General Motors Research Laboratories**

Warren, Michigan 48090

Volume 79, Number 6 May, 1977

# Technology Review

Technology Review, Reg. U.S. Patent Office, is published eight times each year (in October/November, December, January, February, March/April, May, June and July/August) at the Massachusetts Institute of Technology: two special editions are provided to graduate (pp. A1-A16) and undergraduate (pp. A1-A16 and B1-B24) alumni of M.I.T. Entire contents copyright 1977 by the Alumni Association of the Massachusetts Institute of Technology. Technology Review is printed by The Lane Press. Inc., Burlington, Vt. Second class postage paid at Boston, Mass., and at additional mailing

Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: Technology Review, Room E19-430, Massachusetts Institute of Technology, Cambridge, Mass., 02139. Telephone area code (617) 253-4872

Price: \$2 per copy. Subscriptions: in the U.S., Canada, and Mexico — \$15 one year, \$24 two years, \$32 three years; overseas \$23 one year, \$38 two years, \$50 three years. Please allow three weeks for changes of address and give both old and new addresses in all requests.

Technology Review is represented for advertising by: Littell-Murray-Barnhill, Inc., 60 E. 42nd Street, New York, N.Y., 10017, telephone (212) 867-3660; Cemcon, 4 N. Elmhurst Street, Prospect Heights, Ill., telephone (312) 398-0794; Zander, Coughlin and Bigler, 5478 Wilshire Boulevard, Los Angeles, Calif., 90036, telephone (213) 938-0111 and 22 Battery Street, San Francisco, Calif., 94111, telephone (415) 398-4444.

Publisher James A. Champy

Board of Editors John I. Mattill (Editor), Dennis L. Meredith, Michael Feirtag, Sara Jane Neustadtl, Marjorie Lyon, Deborah McGill, Susanne Fairclough

Production Kathleen B. Sayre

Advertising Richard F. Wright

Subscription Service Dorothy R. Finnerty

### **Articles**

#### The Nuclear Wastes at West Valley, **New York**

Richard K. Lester and David J. Rose

Six hundred thousand gallons of high-level radioactive waste lie in a tank that will eventually corrode. What should be done? And who should be responsible for doing it?

#### The Chemical Conversion of Sunlight

Mark S. Wrighton

Through the use of semiconductors immersed in liquid electrolytes, the energy of the sun can be changed to electricity or used to generate storable fuels

#### The Promise of the Space Factory Donald M. Waltz

An enormous range of commercial products, from electronic components to medicines, could be manufactured in space. The quality would be higher, the costs favorable; but some hardnosed research is needed

#### The Politics of Urban Transportation Innovation

Alan A. Altshuler

In urban transportation, it's the politics that matter - not the technology or even the sense

# Departments

20

30

38

Design by Nancy Pokross

#### Technology/Society On the dangers of istisms, not including moralists Kenneth E. Boulding

Technology/Environment The editors worry about our intellectual impact; now Dr. Nisbet looks at our contribution to the environment 5

10

11

60

#### **Washington Report** Recombinant DNA research on Capitol Hill Colin Norman

Ian C. T. Nisbet

Robert C. Cowen

Science Report Equipped with a versatile calculator, now at new, lower prices, you hardly have to think at all

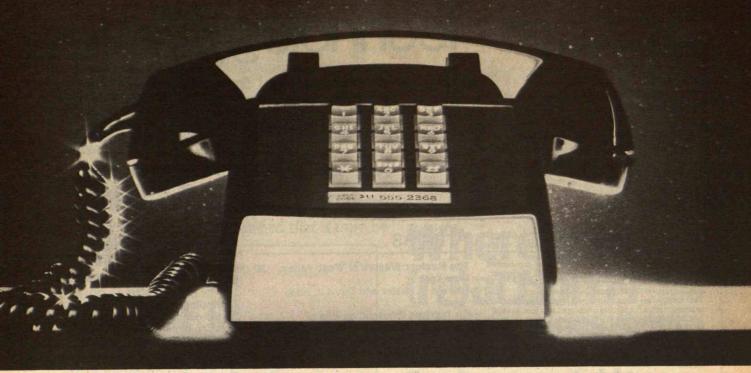
#### **National Report** How heavy the hand of energy on the future of mankind? David F. Salisbury

**Books and Comments** Cleaning Up America: An Insider's View of the Environmental Protection Agency, reviewed by George A. W. Boehm

#### **Trend of Affairs** Recombinant DNA, 12 Earth and Space, 14 Nuclear Power, 16

**Puzzle Corner** Fun at the factory, and other problems not so speedy Allan J. Gottlieb

#### Technology Review, May 1977



# There's at least one thing you can afford that's the very best on earth.

American telephone service is the best in the world. Yet it's well within the reach of virtually every American.

This didn't happen by accident.
Both the quality and economy
of your telephone service benefit
greatly from technological innovations Bell Laboratories and Western
Electric produce for the Bell System.

#### Money Well Spent...

Genuine innovation doesn't come cheap.

But the money Western Electric spends on research and development at Bell Labs produces a lot of innovation.

About 40% of what Western Electric makes today didn't exist in 1972.

That's triple the amount of innovation of industry in general.

Though such innovation costs a lot, it saves you money.

#### ... Saves You Money.

Take long distance calling, for example. It's one of the few things that costs little more today than 25 years ago. That's because technological improvements have helped hold costs down.

For example, we have increased the capacity of coaxial cable systems from 600 simultaneous conversations in 1941 to 132,000 today.

We've increased sevenfold the capacity of our major microwave transmission system.

And our largest electronic switching system can handle four times the capacity of the previous system.

Innovations like these involve answering engineer-

ing and manufacturing questions at the forefront of technology.

Without the intimate flow of information that exists between Bell Labs and Western Electric, many of our innovations would have been much longer in coming.

Some might not have come at all.

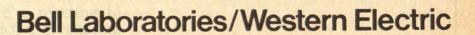
#### **A Complex Future.**

Many future innovations will be even more complex, requiring even closer interaction.

As part of the Bell System, Western Electric and Bell Labs will continue to put technology to work for you

So even if you can't afford the best of everything, you'll still

be able to afford the best of something: The best telephone service on earth.



# Guilt by **Association**

"We assume that everything in a pigeonhole is a pigeon, when in fact all pigeonholes contain a vast variety of birds, and even a vast variety of pigeons."



Technology/Society by Kenneth E. Boulding

Moral references, as economists often fail to know, are very largely learned. Children learn discretion from other people, from the communication that says, think your preferences are miserable." This often takes the form of a slightly raised eyebrow, an acid inflection of the voice, or a subtle grimace, and conveys far more powerfully than any preaching that the individual is not conforming to the approved preferences of his peers.

Of course, values are also expressed by approval: nods, smiles, and honeyed tones. Positive adjectives - fine, decent, sincere, honest — line up against negative adjectives - cheater, racist, sexist, S.O.B., M.C.P., and so on. Psychological learning theory holds that positive reinforcement is more effective in changing behavior than is negative. It would be interesting to compare cultures according to the frequency of negative versus positive adjectives to describe behavior. One has the feeling that, in many languages, negative adjectives and cuss words are much more powerful, picturesque, and interesting than positive adjectives, and this perhaps explains why cultural values are so often ineffective in changing behavior.

One vector of the moral thrust in our own society is the disapproval of discrimination. It is manifest most vividly in such words as racist, sexist, and so on — a

convention I shall call "istism." There is something in the "ist" sound which conveys almost snakelike hissing and venom. There is a group of "ist" words — communist, capitalist, socialist, ritualist, plagiarist, masochist, sadist, atheist, and even theist — all of which are pejorative in some circles. Of course, a few neutral "ists" exist, as well: botanist, chemist, physicist, and geologist, for example. But I confess I sometimes hear the word 'economist" invoked with nasty vehemence.

**Pigeonholes** 

Ironically enough, where the moral thrust abjurs discrimination — as in the terms racist and sexist — it often tokens a failure to discriminate. It is the undiscriminating who are the discriminators, through some quirk of language. The racist lumps all members of one race in a single adverse judgment, without recognizing that within any group there are enormous individual differences, usually more significant than the differences between groups. But the "istist" — who is quick to cry "racist" or "sexist" — is equally guilty of assigning people to imprecise categories.

The truth, as William Blake says, is in minute particulars. Hence the fallacy of istism is the fallacy of heterogeneous categorization, or what might be called

the "pigeonhole fallacy." We assume that everything in a pigeonhole is a pigeon, when in fact all pigeonholes contain a vast variety of birds, and even a vast variety of pigeons. The istist risks lumping together racist and sexist, when the people accused may be very different.

Shorties and Uglies

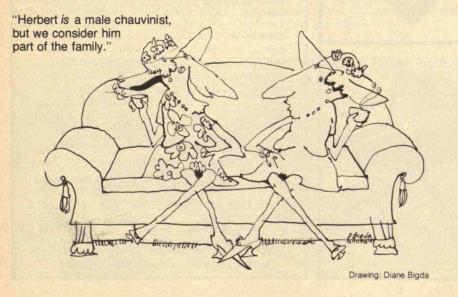
Istism has its dangers. When it prompts negative sanctions, the result is often counterproductive: the law only knows how to punish, and is extraordinarily ineffective when it comes to rewards. And because it is much more fun to denounce than to praise, istists can easily fall into the same trap as the people they de-

By concentrating on a few pet discriminations, the istist may be oblivious to some others. The "ageist," who advocates compulsory retirement at an arbitrary age, is a favorite target of my raised bushy eyebrows at the moment. There are no affirmative action sanctions for discrimination against shorties, although there is a lot of evidence that short people are discriminated against in favor of tall people. It would be still harder to initiate affirmative action for uglies, yet superficial characteristics - voice, deportment, and so on - may handicap otherwise worthy and potentially productive people.

A peculiar form of discrimination to which moralists are particularly susceptible is richism - the blanket condemnation of anybody much richer than the moralist. Conversely, there is poorism —the assumption that all poor people are alike in their shiftlessness. There are dangers even in discriminating taste. The person whose taste is too highly discriminating may prove a snob and a purist. And then we worry about discrimination against purists.

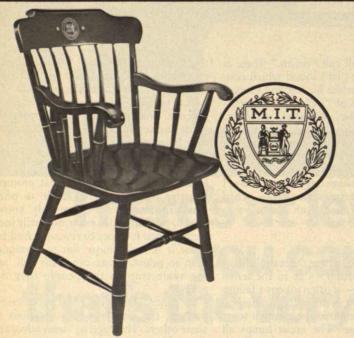
It is a tough world for the moralist. One always seems to end by affirming the Aristotelian mean, although that is very hard to locate.

Kenneth E. Boulding is Professor of Economics and a director of the Institute of Behavioral Science at the University of Colorado at Boulder. He writes regularly for Technology Review.



# M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER











M.I.T. CHAIR. A traditional favorite made of selected northern hardwoods and finished in satiny black with gold trim and gold M.I.T. crest. In all black or black with cherry arms.

M.I.T. CHAIR CUSHION. Tough Duraleather cushion in deep red with grey piping and 2" thick foam filling. 13.00

M.I.T. PLAQUE. Bronze seal mounted on solid walnut shield or rectangle. Comes with self-adhering brass nameplate. 27.95

For two lines of engraving, add 7.00

M.I.T. INSIGNIA TIE. A distinctive way to show off the M.I.T. shield. Fine quality polyester with repeat pattern on maroon or navy ground. 4" wide. 6.95

INSIGNIA GLASSWARE. Hand-blown with silvery M.I.T. seal and platinum rim. Available in Hi-ball, Single or Double Old Fashioned.

DIRECTOR'S CHAIR. Sturdy folding hardwood frame in natural or black finish. Seat and back in heavy white cotton duck with 3-color M.I.T. seal. 33.95

DIRECTOR'S CHAIR with walnut finished hardwood frame. 41.90



M.I.T. Student Center 84 Massachusetts Avenue Cambridge, Mass. 02139

1977

Quan.	
M.I.T. Chair, cherry arms	Express Collect 75.00
M.I.T. Chair, all black	Express Collect 75.00
M.I.T. Chair Cushion	13.00
M.I.T. Insignia Tie in navy	6.95
M.I.T. Insignia Tie in maroon	6.95
Hi-ball Glasses	2.50
Single Old Fashioned	2.50
Double Old Fashioned	2.50
Director's Chair ( ) natural, (	) black 33.95
Director's Chair in walnut	41.90
Plaque	27.95
Engraving	7.00
( )Shield, ( ) Rectangle	
Name to be Engraved	
Class of	
Please ship to:	Live Attin aspiete
Street	City

Mass. Residents: Add 5% sales tax (except ties).
Out-of-state Residents: No tax except when delivered in Mass.
SHIPPING AND HANDLING (Continental U.S.A.)

☐ CHARGE MY ACCOUNT ☐ OR I ENCLOSE REMITTANCE

 Director's Chair, Glassware
 (per order)
 2.50
 3.50
 4.50

 Personalized Plaque
 (per order)
 1.25
 1.75
 2.25

 M.I.T. Chair Cushion & Tie
 (per order)
 1.00
 1.25
 1.50

M.I.T. Chairs: Freight charges collected upon delivery. Please allow approximately 4 weeks for delivery.

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

# This Essay Is Trash

"The truly thoughtful environmentalist will minimize the need to recycle by using re-usable products whenever possible."



Technology/Environment by lan C. T. Nisbet

Whether or not this page deserves to be characterized as trash from the outset, it is destined to become so before long. Even my most devoted readers do not keep my articles for many weeks, and most copies of Technology Review are discarded within a few months. Weighing in at about 160 grams per copy, each number of the Review therefore generates nearly ten tons of waste paper. Some of this is recycled, of course, but then the magazine's superior paper coatings and inks end up as troublesome water pollutants. As a contributor to environmental pollution, the Review is doubtless trivial compared with the Sunday New York Times or Playboy. However, even those of us who believe that Technology Review's ratio of intellectual content to environmental impact exceeds that of the Times and Playboy should not overlook its contribution to the nation's swelling piles of trash.

#### **Discards**

Trash is an emotional subject. It is at once a symbol of affluence — of a society which can afford to discard used goods and replace them with new ones - and a symbol of waste - of a society which squanders its resources and fouls its own nest. The growing stream of solid waste presents environmental problems which have proved unusually intractable, perhaps because we have tried to tackle them with technological solutions. Nontechnological solutions - recycling, reuse, and non-use - promise to reduce waste at its source; big machines can only sort it and recover part of the useful resources it contains.

Statistics tell us that the average person in the United States discards more than five pounds of household trash every day, still more if we count his contribution to the generation of industrial solid waste. I have monitored the trash generated by my own household for several months. Even making generous allowance for delayed disposal of large household items which accumulate slowly over the years, we discard less than one-sixth of the national per capita average. The discrepancy is so great that I find it hard to imagine what the average person finds to throw away. Perhaps we are missing some essential part of the modern experience. Probably we are not doing our bit to keep the consumer economy ticking over. But I suspect that our habits are more economically and socially sound than most families'.

Admittedly, we have unusual opportunities to limit the amount of trash we can't recycle. We live in a town with a collection service for organic wastes, which are used as pig food. And we have enough space to compost most organic wastes, to the benefit of our garden. We routinely recycle paper, glass, and metal. So although we must sort our garbage into as many as eight separate categories, the cost of this sorting is negligible, and it takes only one or two hours per month.

#### Soft Drinks vs. Frozen Lemonade

Still, I wonder whether voluntary recycling is the best response to the trash problem. In the long run, of course, recycling makes good economic sense, and will have to be incorporated progressively into the economic system as materials and energy dwindle and become more expensive. However, re-using goods is generally more efficient and thrifty than recycling the materials in them. We ought to devise systems to reward manufacturers and consumers who make and use durable, re-usable products, and penalize those who make and use throwaway products. Ironically, voluntary recycling may actually delay this solution by relieving the pressure of diminishing resources. (This is well understood by the manufacturers of throwaway products, who promote voluntary recycling through such organizations as "Keep America Beautiful.")

The truly thoughtful environmentalist will minimize the need to recycle by using re-usable products wherever possible. For example, I avoid a lot of waste-and save a lot of money-by buying beer in returnable bottles and by avoiding carbonated soft drinks. (Frozen lemonade is cheaper and more nutritious in any case.)

Viewed in economic terms, trash is the natural consequence of affluence. As society becomes wealthier, the time and manpower required to repair equipment or to sort materials for re-use and recycling (Continued on p. 59)



# City, State, and Congress at Odds on DNA Research

"It will be politically difficult for a Congressman to vote for a measure which would take power from the hands of his own constituents."



Washington Report by Colin Norman

In mid-March the recombinant DNA debate which has been raging on college campuses and in state and local governments around the country, suddenly erupted on Capitol Hill in a flurry of bills, a series of public hearings, and a raft of statements by concerned representatives of the people. What began in 1973 as an unprecedented attempt by a section of the scientific community to regulate itself was about to be superceded by an equally unprecedented move to legislate controls on an area of basic research.

This surge of congressional interest in the new technique of gene splicing was once dreaded by practitioners of the technique, who feared imposition of unduly harsh controls by politicians who wouldn't have the time or the training to understand the issues. But by the time Congress became interested in the research, many scientists were actually urging it to take action. Even a spokesman for the drug industry, which is certainly no fan of federal regulation, testified before one committee in the House, "We do believe that legislation is necessary."

What happened to make legislation suddenly desirable to those who would be

most directly affected by it?

The short answer is the recent entry of state and local governments into the debate, establishing their interest in local regulations to control recombinant DNA experiments. Many scientists are anxious to prevent a patchwork of state and local controls of varying stringency, so that researchers in one city would be working under controls different from those imposed on their colleagues working elsewhere. It would be nonsensical, for example, for scientists in Cambridge to be forced to work under strict controls while other researchers across the Charles River in Boston performed the same experiments under more lax conditions.

#### Congressional Pre-emption

Most would-be gene splicers hope that Congress will establish regulations binding on everybody who wants to do recombinant DNA experiments, and that the regulations will pre-empt state and local controls. There is a precedent of sorts in the nuclear area, where federal radiation standards take precedence over controls established by state governments.

Yet some important principles concern-

ing public participation in science policymaking are at stake here, and it's far from certain that Congress will oblige by pre-empting the work of state and local governments.

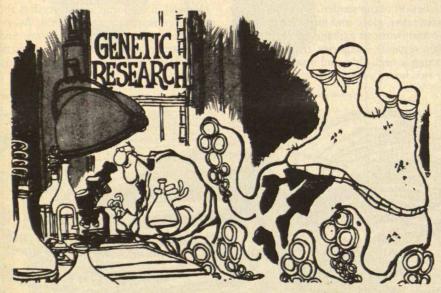
Without repeating discussion elsewhere in the Review (see October|November, 1976, pp. 10-12; December 1976, pp. 10-11; February, 1977, pp. 10-11; and May, 1977, pp. 12-13) it is worth noting that until guidelines to control recombinant DNA experiments were issued by the National Institutes of Health (N.I.H.) in June, 1976, the debate over whether, and under what conditions, recombinant DNA research should take place was confined largely to the scientific community. It was scientists themselves who, commendably, raised the issue of whether transplanting genes from disparate species into microbes might present a health hazard. And a committee of scientists was largely responsible for drafting the N.I.H. guidelines.

Not until last July was the public brought into the debate in a significant way. Mayor Alfred Velucci and the Cambridge City Council imposed a moratorium on some types of recombinant DNA experiments in Cambridge and set up a review board of Cambridge citizens to recommend the conditions, if any, under which the research should be permitted.

Since then, state government units in New York and California have held hearings and developed legislation of their own. New Jersey and Pennsylvania are planning hearings, and committees in Princeton, Madison, Bloomington, and San Diego have held — or are planning to hold — hearings. Never before has an area of basic research been subjected to so much scrutiny by lay persons.

#### Talk between Town and Gown

Two issues have particularly concerned state and local governments. First, the N.I.H. guidelines formally apply only to research supported by the federal government, which means that industrial research is essentially unregulated. And second, the guidelines are not backed by any external mechanism to ensure that they are followed. Thus, the local controls im-



I GIVE UP, CHARLIE...WHAT HAS SIX LEGS, FOUR EYES AND EATS LIQUID NITROGEN?

Illustration: Mike Peters; United Features Syndicate

posed or being written - including the regulations adopted in Cambridge - essentially put the N.I.H. guidelines into a form enforceable by state and local agencies, and they also make the controls applicable to everybody, including industry.

In the meantime, a committee of officials from some 16 federal agencies was established last November to seek ways to extend the N.I.H. guidelines to cover research supported by non-government funds. The committee, chaired by N.I.H. Director Donald Fredrickson, concluded that no existing federal law can be used to regulate the research, and in March it recommended that the administration should draft a bill to turn the guidelines into regulations enforceable by an agency of the Department of Health, Education and Welfare. H.E.W. Secretary Joseph Califano immediately accepted the recommendation and announced that his department would draft such a bill. It was to be introduced into Congress early in April.

By mid-March, therefore, the administration was pressing for legislation and many prominent scientists were hoping that Congress would act speedily to preempt local controls. And Congress itself was not sitting idly by. Early in March, Paul Rogers, Chairman of the Health Subcommittee in the House of Representatives, proposed a bill and conducted three long days of hearings on the measure. Two weeks later, the House Committee on Science and Technology was due to hold three days of hearings, and on the other side of the Capitol, Senator Edward Kennedy, Rogers's counterpart in the Senate, announced that the Senate Health Subcommittee would hold a hearing on April 6. Senator Kennedy was expected to propose his own bill after the hearing.

#### **Uniform Controls**

Thus, Congress suddenly found itself grappling with complex issues of genetic research and forced to judge issues on which scientists themselves are sharply divided. Nevertheless, there seems at the outset to be substantial agreement among the administration, Representative Rogers, and Senator Kennedy on some important aspects of the legislation. To begin with, it seems certain that the final bill will direct the Secretary of H.E.W. to issue regulations based on the N.I.H. guidelines, so Congress isn't about to rewrite the ground rules which have been hammered out by N.I.H. And second, the bill is expected to establish a licensing and registration scheme under which either researchers themselves or the facilities they work in would have to obtain licenses for recombinant DNA research. And third, the bill is likely to require H.E.W., probably through the Center for Disease Control in Atlanta, to monitor compliance with the regulations by inspecting facilities, requiring record-keeping, and so

The major obstacle to the bill's passage

will be the federal pre-emption of state and local controls. The administration's bill will contain such a provision, but Congress may not go along with it. The need for uniform controls must be balanced by the possibility that federal pre-emption will throttle the debates which have been going on in communities around the country - debates which have summoned an unprecedented public input into science policymaking.

At this writing, it's not certain how the debate over federal pre-emption will be resolved, but clearly it will be politically difficult for a Congressman to vote for a measure which would take power from the hands of his own constitutents. In any case, the need to ensure public participation in the decisionmaking process - not just for recombinant DNA research but for other science policy matters as well -is likely to prove critical.

So far, every committee which has looked into the pros and cons of allowing recombinant DNA research to go ahead has given its approval and, in the process, there has been some much-needed communication between town and gown. Congress would be wise to nurture rather than stifle these new channels of communication.

Colin Norman is Washington Correspondent for Nature and a regular contributor to Technology Review.

We have an opportunity for a . . .

#### Systems **Analysis Engineer**

A PhD Physics/EE/Optics, for modeling and analysis of complex laser and other electro-magnetic systems to determine feasibility, optimize designs or estimate cost/effectiveness. The problems are multi-disciplinary. Some of the requirements are: the ability to work with real world data and make physically sound approximations when necessary, flexibility in applying fundamental principles to new areas, and the ability to work with other scientists and engineers in related areas.

This opening provides a chance to join the company ranked seventh in the U.S. in private R&D spending, and live in an attractive New England setting. Please submit your detailed resume with salary requirements to: T. R. Marcin, Professional Placement, Silver Lane, East Hartford, Conn. 06108. Local interviews can be arranged.

# UNITED TECHNOLOGIES RESEARCH CENTER



An equal opportunity employer

### PROFESSIONAL ENGINEERING FOR CAPITAL EXPENDITURE PROGRAMS

provides COMPREHENSIVE SERVICES:

- CONCEPTUAL PLANNING to establish FINANCIAL FEASIBILITY
- PROJECT PLANNING for CAPITAL APPROPRIATION
- IMPLEMENTATION SERVICES for AUTHORIZED PROGRAMS

### TO ACHIEVE THE CLIENT'S INVESTMENT OBJECTIVE.



POWER . INDUSTRY . ENVIRONMENT CHAS. T. MAIN, INC. BOSTON • CHARLOTTE • DENVER • PORTLAND • TEHRAN PANAMA • BUENOS AIRES • JAKARTA • LAGOS

# Writing and Reading and Calculations

It is likely that schools will begin teaching paper-and-pencil algorithms as another way to do calculations, but not the principal way."



Science Report by Robert Cowen

To Leonard J. Donohoe of Texas Instruments, calculators are a bridge across which the mathematically illiterate will walk into the world of the home computer. To George E. Lindamood of the National Bureau of Standards, they are the heralds of cultural revolution. And to Max S. Bell of the University of Chicago, they are a powerful — and controversial — tool with which children can transcend the tedium of arithmetic drill to discover deeper meaning in, and wider use for, mathematics.

When these men prophesied at the annual meeting of the American Association for the Advancement of Science, they offered more hopes and hunches than definite predictions. Nevertheless, one substantial fact justifies their vision: the hand-held electronic calculator, whose advanced versions amount to miniature computers, offers a new mathematical capability for the individual user.

For the homemaker, the student, or the business executive, the ability to let your fingers do the dog work while your mind focuses on what the mathematics can tell you is a capability whose value we're scarcely beginning to appreciate.

Mr. Donohoe expects the result will be a more mathematically competent population. "We're in the age of distributive computing," he says. "It's now in our hands, in our homes, and it's going to grow. Calculator technology is taking us beyond the hand-held calculator, per se, to the home computer — the home entertainment and education center." Mr. Lindamood agrees that "calculators represent the first wave of acceptance of the computer by every person," although he can sense only dimly what its implications may be. "The slide rule is gone .... But calculators are part of a broader movement — the digital computer revolution that has yet to run its course and that will have social implications. All of a sudden, in the calculator, we have a consumeroriented, computer-like device that is mass-marketed. We can at least remember that, while we shape our tools, our tools will afterwards shape us."

The calculator's popularity is reflected in market statistics. Worldwide calculator

sales in 1975 totaled some 53 million units and \$1.7 billion. For 1976, the figures are 70 million units and \$1.65 billion, with North America accounting for 40 to 45 per cent of the market and Europe accounting for 30 per cent. Although some of the calculators were replacements, those sales volume figures largely represent market growth, while the dollar figures reflect the continuing fall of prices. Significantly, in the U.S. at least, half of the purchases are made by housewives and students, according to a survey by Richard K. Shumway of Ohio State University.

Expectations of future trends are harder to quantify, largely because companies keep their best estimates to themselves, but the outlook seems rosy. Mr. Donohoe, who manages the component design department at Texas Instruments, says his company doesn't expect market saturation until the late 1980s. He defines saturation as the condition where the market grows only as the population grows. As to cost, he doesn't expect the average price to drop below about \$12 a unit. On the other hand, he says he can see no end to the drop in cost of capability, that is, he expects to continue to improve calculator performance per dollar.

His prediction is justified most dramatically by top-of-the-line scientific calculators: Texas Instruments' sr-52 and Hewlett-Packard's HP-67. Selling for \$250 to \$450, depending on your discount house, these machines, programmed by magnetic card and able to make logical decisions, approach the capability of a \$150,000 computer of the early 1960s.

However, even the simple four-function calculator represents computing power an order of magnitude beyond anything you can do with paper, pencil, and tables. That's why Dr. Bell thinks the hesitation to put this power into the hands of young children is a shame. Far from preventing them from learning arithmetic, he and some other educators believe the calculator could help to overcome the national scandal of elementary mathematics teaching: the general inability to use arithmetic skills in a practical way. "Johnny can add," observes Dr. Bell; "he just can't do

anything with addition." Eight years of arithmetic drill "really doesn't teach all that much," he maintains.

**Practical Illiteracy** 

The 1972-73 National Assessment of Mathematics, a test given every five years throughout the U.S., partially documents the problem. Ninety-two per cent of 17-year-olds and 86 per cent of adults could add columns of dollars and cents correctly. But a moderately complicated checkbook problem threw all but 1 per cent of the 17-year-olds and 16 per cent of the adults into a quandary.

The National Council of Supervisors of Mathematics, concerned about this lack of skill, has drawn up a list of ten skills one should gain from an elementary mathematics education: general problem solving; application in everyday situations; alertness to reasonableness of answers; estimation and approximation; appropriate computational skill including ability to manipulate whole numbers, fractions, and decimals; geometry; measurement; ability to use and construct tables, charts, and graphs; simple statistical methods of prediction and probability; and computer literacy.

In a highly unscientific survey, I asked one of my office colleagues how he scored on this list. He said he could qualify except for computer literacy and statistics. But he added, "I think I'm unusual. Most of my friends can't do these things. I feel sorry for them." As though to make the point, a second colleague, an editor in his 50s, came over to ask how to figure a percentage. It's sad, but typical of the deficiency Dr. Bell is talking about.

It's also sad that many teachers and parents, reportedly, are dead-set against letting children use calculators. No one is suggesting that the machines preempt the learning of basic arithmetic skills. Marilyn Suydam, Assistant Professor of Mathematics Education at Ohio State University, has surveyed calculator use in schools for the National Science Foundation. She explains: "Few educators believe that children should use calculators in place of learning basic mathematical skills. Rather, there is strong belief that calculators can help

children to develop and learn more mathematical skills and ideas than is otherwise possible."

Summarizing Dr. Suydam's findings, the National Science Foundation mag-azine Mosaic notes: "The sequence of mathematics learning can be altered. Children, for example, now learn the addition of whole numbers before decimals because they must learn the addition of whole numbers before they can handle decimals. On the calculator . . . the same button is pushed for both computations. It may no longer be necessary to delay decimals until the fifth grade. Similarly, the calculator and the advent in the U.S. of the metric system could sharply diminish the importance of fractions ... Negative numbers, a concept not easy to teach to younger students, may become more tractable. . ."

#### How Many Seconds Have I Lived?

"Simple" calculators are rapidly evolving beyond four functions. They can perform square roots, raise numbers to powers, and compute trigonometric functions and logarithms. All of which leads Dr. Suydam to suggest that elementary math-teaching "need no longer be based on whether or not children can perform the calculations, but rather on whether they understand the concepts involved."

Dr. Bell, for his part, is unimpressed by the fear that calculators would be a crutch. As an experiment, he and his colleague Zalman Usiskin handed out calculators in 20 elementary classes. Far from being a crutch, he says, once children became bored with fiddling with the keys, they began to ask interesting questions, such as "how many seconds have I lived?" — questions they wouldn't have considered asking before they had a tool to cut through tedious computation.

Probably the most compelling argument for introducing children to calculators is that these handy machines are coming utterly to dominate the numerical work of the world. Already, any college course that once used slide rules and tables, or relied on simple computer facilities, is encouraging unrestricted use of calculators. This means the education of the college-

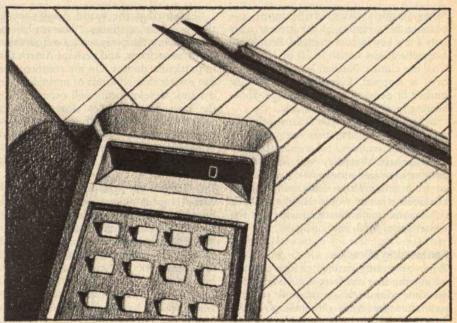


Illustration: Judy Richland

bound must include competence in using the calculator. And in the work place, there are few people, professional or not, who adhere to old-fashioned paper and pencil methods.

Calculators, says Dr. Bell, "are one of the greatest self-learning tools ever invented" for people who are well beyond school. "I wonder how many people, like myself, had a knowledge of statistics, for example, which they let slip because figuring a standard deviation by hand is a pain in the neck. A scientific calculator can do it in a flash, and do a lot of other statistical analyses as well. With that kind of help, I am recovering the lost knowledge and find it invaluable in assessing many of the documents a science writer has to digest."

Mr. Donohoe predicts that the capabilities of calculators, even cheap ones, will increase rapidly over the next five years. This will be expressed in the emergence of special-purpose units designed for jobs ranging from professional and business computing to helping children learn. Indeed, the Novus (Owl)

"Quiz Kid," Texas Instruments' "Little Professor" arithmetic-teaching machines, and Texas Instruments' educational calculator kits are steps in this direction.

Mr. Lindamood, who keeps tabs on international computer technology, feels that "calculators are softening us up for a cultural advance as beneficial as the decimal system — but I don't know what it is." Certainly, it seems that we are heading into an era when we won't use, or neglect to use, math like we used to. Dr. Suydam forecasts that, at least, "it is likely that schools will begin teaching paperand-pencil algorithms as another way to do calculations, but not the principal way." I think her prediction is too conservative.

Robert C. Cowen is Science Editor of the Christian Science Monitor and writes regularly for Technology Review.

### Deliverance

"The nation is like a man waking up in the drunk tank after an all-night spree."



National Report by David F. Salisbury

Many people's vision of the future appears to be a replica of the present with only a few key factors changed. Petroleum and natural gas vanish in 20 or 30 years. Coal use climbs. Nuclear energy increases or it is stopped. Energy conservation is pushed or demand rises unchecked. Solar heating grows slowly or quickly.

These projections have a curiously unreal quality because they are divorced from social realities. How many people really believe that they will not own a gasoline-powered automobile a decade or so from now? How many people have imagined what it would be like to have continuous unit trains running from the western coal fields to Chicago?

#### **Fantasizing Miracles**

While projecting various energy changes we assume that our lives will be basically the same tomorrow as today. A year or two after the Arab oil embargo Congressman Mike McCormack came up with an apt but humorous simile for the nation's response to the energy crisis.

"The nation is like a man waking up in the drunk tank after an all-night spree. First he refuses to believe he is there and tries to go back to sleep. When this fails, he begins to fantasize that the doors will suddenly open and he can walk out free as a bird. But finally, he is forced to face up to the facts."

Many Americans still refuse to believe that the energy crisis is real. And the rest of us appear to be convinced that some technology — the breeder reactor, fusion, or some form of solar energy — will save the day. We continue to fantasize some miraculous form of deliverance.

Perhaps this helps explain the "curiously static quality" of many of the proposed solutions to the energy dilemma noted by Charles J. Hitch of Resources for the Future in the March 4 issue of *Science*.

"Not only are these technologies seen by their enthusiasts as total solutions, which is itself a presumptive notion, but also they seem to be advanced as if a decision could be made now or soon about the most economical, clean, and safe way to provide energy for the next 1,000 years," Mr. Hitch writes. "Except that the world doesn't work that way," he continues. "Human beings do not work that way, either as individuals or as societies, and perhaps Americans in particular do not. On the contrary, we can expect that all kinds of unpredictable dynamic developments will occur during the next 25 years, let alone the next 1,000." He ends the editorial with a demand that we not freeze our future options, either in our minds or our machinery.

#### Pro-Growth vs. Post-Industrial

There is great poignancy in Mr. Hitch's plea because views of the energy future have become extremely polarized. Scenarios of the future tend to cluster around two extremes. One might best be labeled "pro-growth" and the other, "post-industrial."

The basic tenet of the "pro-growth" view, which has been instrumental in forming U.S. energy policy thus far, is the assumption that policies which have worked well in the past are also our best bet for the future. The problem is one of supply, not demand. A technological approach is necessary to assure the development of new energy sources. The primary criteria for decisionmaking is economics.

The opposition view sees a major reordering of social values as essential. The social and environmental costs of continued material and technological growth are intolerably high. Decentralization of control, technology, and population is necessary. Human development rather than economic growth is the primary criterion.

Those who have adopted the progrowth worldview consider the post-industrialists as idealistic, sometimes even dangerously revolutionary. The post-industrialists on the other hand perceive the advocates of growth as irresponsible and inflexible.

"Solar Energy In America's Future," a report prepared for the Energy Research and Development Administration (E.R.D.A.) by the Stanford Research Institute, explores these world views in more detail. It points out that "when persons appear to be arguing about technical issues or choices among energy options, they may in fact be arguing from different fundamental perceptions of the nature of social reality." This is a manifestation of the fact that "man lives by propositions whose validity is a function of his belief in them," an observation made by anthropologist Gregory Bateson.

For some reason, arguments stemming from differing values tend to be emotional and unproductive. When translated into the realm of energy policy, what is in essence pattern-uncertainty has had the effect of slowing and often stalemating the consensus-making process.

This process of polarization rather than acceptance of uncertainty could prove to be our most dangerous form of hubris, and lead to tragic results

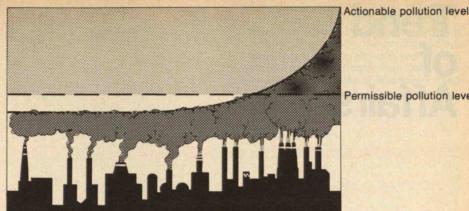
and lead to tragic results.

As Mr. Hitch writes, "Do we really think that we are at the pinnacle of human evolution and development, that all the most important inventions are past or within our grasp? It is possible, but evidence weighs heavily on the side of skepticism. Moreover, we are too ignorant to make even semi-permanent choices and commitments."

The real danger is that overly rigid assumptions about the future will become self-fulfilling and make it impossible to discover the best solutions.

David F. Salisbury reports on science for the Christian Science Monitor from its West Coast bureau and writes regularly for Technology Review.

# **Books** Comments



Permissible pollution level

Environmental laws state in black-or-white terms that any emission below the permissible level is absolutely all right; any above that level is absolutely heinous. In practice, partly because good control

systems sometimes temporarily falter, E.P.A. allows some leeway before it clamps down. The result is this logical absurdity called the "hockey-stick curve." (Chart: Vaughn McGrath)

### E.P.A. **Inside Out**

Cleaning up America: An Insider's View of the Environmental Protection Agency John Quarles Houghton Mifflin, 1976; xvi + 255 pp., \$8.95

#### Reviewed by George A. W. Boehm

"I am a federal bureaucrat" begins this fascinating narrative of one man's experiences in the Washington political arena. Mr. Quarles sticks closely to a single theme: the battle of the fourth branch of government — the bureaucracy — to do its job with the support or opposition of such diverse groups as Congress, the White House staff, the courts, other parts of the bureaucracy, industrial lobbyists, public interest organizations, and (most important) the voting public.

That Mr. Quarles is number-two manon the E.P.A. ladder is almost incidental, although this young agency offers lively examples of what happens within and around a bureaucracy. The book is a text on the realities of government and, as such, should be catalogued in the applied political science section of a library. Its scientific content is otherwise insignificant.

This is not to blame Mr. Quarles for having written a chronology of case histories that show the workings of a big government agency in the limelight. His most cogent observations should apply equally well to the Departments of Agriculture, Defense, Commerce, and others.

His principal message is that in our form of government real power does indeed flow from the people, though sometimes at the speed of molasses. At the start, when public concern for environmental improvements was heated, E.P.A. could exert plenty of power. A critical Congressman admonished the agency's first administrator William Ruckleshaus: "You have more power than a good man would want, or a bad man should have."

But by 1973, when environmentalism lost its momentum, all the laws and court rulings could do little to help E.P.A. make

rapid progress. The reason was that the public had become more deeply concerned about energy shortages and inflationdepression.

**Biding Time** 

Today E.P.A. is in a period of partial stagnation. The 1976 amendments to strengthen clean air and water regulations never got out of Congress, and President Ford twice vetoed laws to protect the environment against the strip mining of coal. Hardly a complaint was murmured by the general public and the media, although organized environmentalist groups cried out in agony.

Mr. Quarles is deeply concerned about this apathy. He points out that there is usually a lag of several years between the emergence of a problem and government action to correct it, and asks: "As the resultant stresses upon the environment and our finite natural resources become increasingly complex, we are posed with a frightening question: Shall we always be able to afford that delay?"

Mr. Quarles has played important roles in all the major environmental fights since Walter Hickel was Secretary of the Interior, before E.P.A. was created to put all environmental matters in the hands of one agency. He has helped quash plans for the Miami jetport that would have menaced wildlife in the Everglades; reduced wholesale dumping of pollutants into waterways and the atmosphere; and pushed plans to clean up automobile exhausts.

Almost all of these battles have been only half-won. Compromise or inconclusiveness are built into the system of government because, Mr. Quarles explains, "The formation of government policy is not an event but a process. It takes place over a period of time and involves a legion of participants, who may never see or

know each other." The best a man in Mr. Quarles's position can hope to do is to be a good power broker among congressional leaders, the Office of Management and Budget, and other public and private groups with a stake in environmental protection regulations. Practical politicians still negotiate in smoke-filled rooms.

Although it is unfair for a reviewer to criticize an author for failing to do what he did not set out to do, this book would have benefited by a chapter or two on E.P.A.'s technological and scientific problems. In these areas, E.P.A. is hobbled by laws that are difficult, sometimes impossible, to administer literally.

#### Permissable Levels

The ridiculous concept of "zero tolerance" crops up from time to time. Zero has become a small number indeed with the advent of instruments such as the gas chromatograph, which can measure a few parts per billion — no more in the case of some pollutants than existed when the U.S. was a primeval wilderness. The more reasonable approach of setting "permissable levels" causes almost as much confusion. If three units of a particular contaminant is legally permissable, should E.P.A. throw the book at a factory that emits 3.1 units? Or should it wait until the permissable level has been egregiously exceeded? And should the manufacturer who reduces pollution to 1 to 2 units be rewarded? Although the laws permit no kinds of discrimination, in reality E.P.A. fudges a bit by basing actions on the socalled "hockey-stick curve" (see chart above).

Distressingly, E.P.A. lacks the scientific manpower to do the research needed to set rules for discretionary action or even to evaluate some specific problems. For example, the catalytic attachments meant (Continued on p. 59)

# Trend of Affairs

#### Trends This Month

RECOMBINANT DNA

The debate goes public at the National Academy of Sciences.

EARTH AND SPACE

Trekking on Mars by remote control.... ancient meteorites have unreliable memories. . . . measuring the speed of earth movements.

NUCLEAR POWER

What to do about plutonium? . . . dismantling nuclear power plants. . . misgivings over the nuclear power cycle. . . . divers take a dip in the core.

RECOMBINANT DNA

# The Biologists' Last Stand

Events have overtaken the issues first raised by the biochemists who gathered three years ago at Asilomar to discuss the possible dangers of recombinant DNA research. The research has progressed so rapidly that the experiments then judged possible within ten years are now accomplished fact. Lured by the prospect of new products and profits and goaded by commercial competition, every major pharmaceutical firm has put biologists to work on recombinant DNA. The issues no longer center upon small-scale, university-based fundamental research.

Nevertheless, the forum convened by the National Academy of Sciences in March to discuss the potential dangers and benefits of recombinant DNA research brought the same cast of characters together to plow the same old ground once more.

DNA is the molecule that encodes the abilities of every living cell. With recombinant DNA techniques, scientists can transfer parts of the genetic inheritance of one cell to another, by splicing tiny bits of alien DNA into the new cell. That cell, essentially a man-made organism, thus takes on some of the characteristics of the donor cell and enables scientists to study in detail the abilities bestowed by these genes.

A Familiar Scrimmage

Paul Berg and Daniel Nathans, originators of the research, reiterated their previous positions that the knowledge to be gained will provide essential new insight into human genetic disabilities like diabetes or hemophilia, and may reveal molecular clues to the triggers of cancer. Ray Valentine of the University of California wants to continue his attempts to find the genetic on-off signals that enable bacteria to produce nitrogen in soybean roots; if he succeeds, other crop plants might be given the same nitrogen-producing capabilities. David Baltimore, M.I.T.'s Nobel prizewinning biologist, spoke of society's moral obligation to continue research with such broad potential for good. Any

industrial microbiological process might be improved by recombining genes and their regulators in new ways, said Daniel Nathans of Johns Hopkins; it is possible to imagine the specific design of a bacteria to do a specific job with greatly increased efficiency.

Similiarly, the scientists who have pleaded for caution on other public podiums repeated their statements. Erwin Chargaff, the patriarch of biologists, worries over the choice of E. coli, a bacteria commonly found in the human gut, as the host organism in recombinant DNA experiments; he holds that knowledge of the proliferation of that bacteria is inadequate. Harvard's George Wald, long an opponent of recombinant DNA research on college campuses, called for the research to be limited to a small number of high-security laboratories. Robert L. Sinsheimer of California Institute of Technology proposes that "science has not taken so large a step into the unknown since Rutherford began to split atoms,' and that recombinant research represents a "profound intervention in the evolutionary process." This is terra incognita, he said, in which we are "ignorant of the extent of our ignorance."

The academic answers to these criticisms were also familiar, and the questions again were centered on freedom of scientific inquiry, and the responsibility of the scientist to the public who funds him.

As voiced by Daniel E. Koshland, who introduced and arranged the forum, scientists have implicit trust in the value of scientific inquiry. "The job of the scientist is the creation of goodness," the University of California biochemist told the audience. "The job of the regulators is to prevent evil."

Who Will Pay?

But all this is now made academic by the spread of recombinant techniques into industrial research and even development. In fact, said Roger E. Noll of Stanford University, who was the only economist

Protest over recombinant DNA research took the form of banners and songs at a National Academy of Sciences forum early in March. Minutes after this photograph was taken, one irate scientist attacked the sign with his penknife. (Photo: Paul Conklin for the National Academy of Sciences Forum)



on the Academy's list of speakers, "This is probably the last such gathering that will be dominated by the biologists."

The questions now are those of costs of the highly complex laboratories much of the research requires for the products which will be marketed, and of the insurance and liability necessary to protect against uncertain risk, said Dr. Noll. Legislation must protect the public against the acknowledged but uncertain dangers of today's research, and be flexible enough to provide protection as the research gains sophistication as well. The biologists' future role will be limited to that of advisers to legislators, he said.

Anthony Mazzocchi of the Oil, Chemical, and Atomic Workers Union raised another issue: "If anything bad can happen, it will, and it will be the workers who will feel the effects," he said. Workers were falsely assured of their safety in the

nuclear industry and were sadly disillusioned. Data which could have alerted them to the possibilities of occupational cancer and other work-related disease in chemical industries were not disseminated by the scientists who had the information, he said. Unions and workers, on the basis of their past experience, are not reassured by regulations and congressional subcommittees. "The burden of proof [of the safety of the research] lies with those who wish to introduce the process," said Mr. Mazzocchi.

#### "We Shall Not Be Cloned"

Then came the People's Business Commission, formerly the People's Bicentennial Commission, who invaded the first meeting of the forum en masse, to the accompaniment of banners, signs, and songs of "We Shall Not Be Cloned." The real issue, said Jeremy Rifkin, speaking for the

P.B.C., is whether industry has the right to patent new forms of life. His colleague Ted Howard warned of more demonstrations to come. "We shall not go gently into that brave new world" of human genetic manipulation, he said.

Until now the only national constraints upon research biologists have been those established by the National Institutes of Health last June, and these regulations only apply to research funded by N.I.H. grants. The Commerce Department has written regulations to allow pharmaceutical companies to patent new processes resulting from recombinant DNA research (they are now being contested both by other federal agencies and by public interest groups) and pharmaceutical companies must state in patent applications only that those regulations have been followed in their labs. But now legislation has been put before the state governments



More than Viking landers are needed to unlock the secrets of Mars. The next stage are rovers, traveling in pairs with cameras, instruments, and samplers. Imagine "strolling down a Martian river," mused Carl

Sagan of Cornell University at the American Association for the Advancement of Science last winter. (Illustration: Jet Propulsion Laboratory, California Institute of Technology)

of New York and California, and a federal committee is preparing its report and recommendations for national controls (see Colin Norman, p. 6).

The recombinant DNA debate has turned another corner, and the fate of recombinant research is now a political issue. It is no longer in the hands of biologists; it has entered the process of government decisionmaking, with the ultimate authority in the hands of those representatives of the public who, with their share of confusions and self-interests, make most national decisions. — S.J.N.

EARTH AND SPACE

### Strolling Down a Martian River

After examining 1/10,000,000th of the surface of Mars with "the minimum acceptable experimental package" which could be conceived for the purpose, it's no wonder that scientists are still ambivalent about the existence of life there.

The results of all the Viking experiments to date are "enigmatic" on that ul-

timate question, says Carl Sagan of Cornell University. If the Viking findings are attributed to inorganic processes on Mars, then the evolution of life there is easy to imagine; but if you seek evidence of life itself in the Viking results, then your conclusion must be inconclusive, Dr. Sagan told the American Association for the Advancement of Science this winter.

Countless other riddles about Mars also tempt the Viking team, Dr. Sagan said, because the two landers now on Mars were purposely set down "at the dullest [read "safest"] places we could find." Beyond the horizons of today's Viking pictures lies an unknown, "fabulously heterogeneous" planet with a unique chemistry which we hardly understand at all. Imagine "strolling down a Martian river," mused Dr. Sagan.

All this set the stage for Dr. Sagan's argument for the next stage of Martian exploration - two unmanned roving vehicles to take cameras and instruments, including perhaps samplers and analytical laboratories like those in the Viking landers, to parts of the planet which would be otherwise denied to unmanned explora-

Dr. Sagan argued that it is "well within

our capability to have long excursions" of 100, or even 1,000 kilometers, across the Martian surface.

The most difficult problem for such rovers results from the time required for radio communication to and from Mars. Only 20 minutes after a rover arrived at the lip of a crevasse, for example, could its dangerous predicament be known on earth, and instructions for dealing with the hazard would take another 20 minutes to return to the rover. An unthinkable scenario, from which stem two decisions: rovers will need on-board computers with "a considerable inventory of artificial intelligence - dumb things not to do," said Dr. Sagan, and they will have to travel in pairs so that one can help the other in case of trouble. In pairs, too, they could be programmed for special experiments -stereoscopy and seismic soundings, for

Caltech's Jet Propulsion Laboratory is in fact already at work on the design of the first Martian rovers, called "minirovers," weighing in at about 500 pounds, the size of an average office desk. The design lifetimes are about one Martian year or two earth years, during which each rover would cover 1,000 to 1,500 kilometers at the rate of three or four kilometers a day.

Why not a probe which could land on Mars, collect samples, and return to earth, instead of the rovers? Several problems, argued Dr. Sagan: a "return mission" might cost several billion dollars, much more than the projected rovers; the samples which it collected would have to be sterilized en route back to earth or quarantined upon arrival, and the possibility of living organisms is not easily dismissed; and there is also the problem of pollution of the planet during such a probe's return lift-off. — 1.M.

### Deciphering Meteorites' Secrets

Meteorites, many believe, are chunks of ancient dead planetoids, blown apart by collisions in space. If this is so, meteorites could preserve the only surviving records of the early solar system's magnetic fields.

Magnetic fields are known to permeate space. Either of internal (planetary) origin, or external (solar) origin, they seem to have left their imprint on both earth and space rocks. Work by Aviva Brecher, Research Associate in M.I.T.'s Department of Earth and Planetary Sciences, indicates that carbonaceous chondrites, the most primitive type of meteorite, remember relatively strong magnetic fields, comparable to those of our earth. More recent work on iron meteorites carried out by Dr. Brecher and research assistant Lisa Albright indicates that these "newer," less differentiated meteorites, do not.

Russian scientists had claimed that the

iron meteorites which formed nearly 4.6 billion years ago hold good records of preterrestrial magnetic fields. According to Dr. Brecher, this fallacious belief resulted from the Soviet scientists' failure to separate the two questions of whether the meteorites could contain such records, and whether they in fact do.

Iron meteorites are enormous crystals of iron-nickel alloys, formed in the slow cooling (1° to 100° per million years) of ancient planetary interiors. They are structurally similar to man-made, diffusion-hardened alloys, and thus were impervious to the heat and stress that often affects meteorites entering the earth's atmosphere.

Had a fossilized magnetic record been preserved in the iron meteorites, it would have yielded information about the evolutions of temperature and motion in

the parent planetoids.

"The Russian picture was simple and elegant, and everyone wanted to believe it," said Dr. Brecher. She and Ms. Albright presented their alternative theory in a paper presented to the American Geophysical Union in San Francisco last winter.

"Scientists have inferred that the iron meteorites originated as molten central 'cores' in differentiated asteroidal bodies, tens to hundreds of kilometers in size, said Dr. Brecher. However, she added, she found it extremely unlikely that a magnetic field could remain stable throughout the millions of years it took to cool the cores. The magnetic field of the earth, for example, shifts on the average each million years, and the earth's rocks retain a record of that phenomenon within them. Also, she thought it unlikely that a small cooling core could have maintained the rotation- and heat-driven stirring of its molten planetary center which produced magnetic fields in the earth.

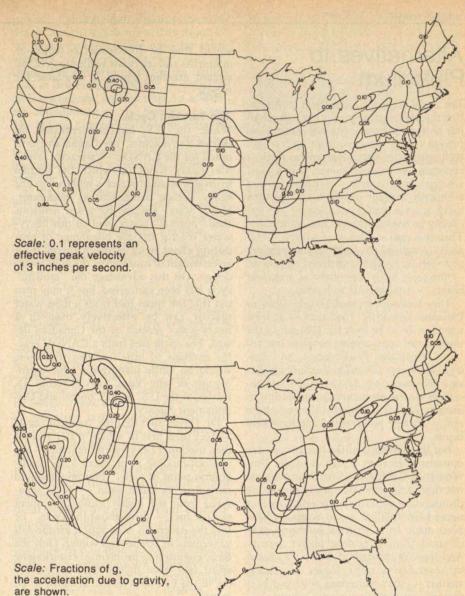
In M.I.T.'s Paleomagnetic Laboratory, Dr. Brecher and Ms. Albright attempted to reproduce the conditions under which the meteorites' magnetism probably occurred. While cooling times of millions of years are admittedly impossible to duplicate, such precision was not necessary. The experiments indicated that the iron meteorites' magnetization tended to align along the principal axes of their crystalline structure, rather than along external magnetic fields. "Our results show that, in fact, no reliable information on their early magnetic environments can be retrieved

- S.J.N.

#### How Earth Quakes

from iron meteorites," Dr. Brecher said.

Three parameters are important in weighing the damage which may be caused by a potential future earthquake: the duration of the earthquake, the velocity of the surface movement caused by it; and the rate of change of this velocity — that is, the ac-



These maps characterize the velocities (above) and accelerations (below) of ground movements due to earthquakes to which U.S. buildings should be resistant. The figures are computed to vary with both the duration and ground movement of likely earthquakes, and they are thought to cover

at least 80 to 95 per cent of earthquakes likely in any 50-year period. The maps are among preliminary results of a new effort sponsored by the National Science Foundation and the National Bureau of Standards to develop national seismic design criteria.

celeration. The three are interrelated. A very short earthquake of high velocity—only one or two cycles of ground motion— is less damaging than an earthquake causing similar motion for many cycles. An earthquake with high acceleration but low velocity is less damaging than one causing higher velocities.

All these factors have now been combined into two maps which tentatively characterize potential earthquake risk in terms of acceleration and velocity throughout the U.S. The analysis, part of a national effort to develop seismic design standards, was reported to the American Society of Civil Engineers last fall by

Neville C. Donovan, Partner in Dames and Moore of San Francisco; Bruce A. Bolt, Director of the University of California's Seismographic Station in Berkeley; and Robert V. Whitman, Professor of Civil Engineering at M.I.T.

The experts believe the probability that their mapped values of risk due to velocity and acceleration will not be exceeded at any one location during a 50-year period is 80 to 95 per cent. The maps, therefore, do not show the most intense motions that are believed possible — but rather the motion and acceleration factors which should be used by designers of most buildings for most purposes. — *I.M.* 

#### Alternatives to Plutonium

The usual scenario for nuclear proliferation through nuclear power has a developing nation, uneasy in its dependence on foreign energy resources, opting for high technology in the form of a nuclear economy — nuclear power plants, fuel storage and handling equipment, and eventually a plant in which to reprocess spent reactor fuel by separating and recycling its useful uranium and plutonium. Then it is easy — almost inevitable — for such a nation to yield to temptation, abandon its pledges, and divert plutonium — the most likely ingredient of a nuclear bomb — from recycle to bomb.

This scenario seemed so plausible to President Gerald R. Ford that — at least temporarily — he took the U.S. out of the nuclear fuel reprocessing business last fall (see "Plutonium, Proliferation, and Policy," by Victor Gilinsky, Technology Review, February, pp. 58-65). And some observers see the problem of proliferation so intractable that it threatens the end of the era of nuclear power before it has fairly

begun.

But the partisans of the nuclear age are optimistic. Herbert F. York of the University of California (San Diego) points out that in 20 years of nuclear power the proliferation scenario outlined above has never been fulfilled — no weapons have been made from material surreptitiously diverted from a nuclear power system. And there is increasing confidence, based on several new technologies now being studied — that plutonium need not be a feature of a mature nuclear economy.

All the power reactors in the U.S.—and therefore most of those in the free world—are so-called "light-water" reactors, in which ordinary water is used to transfer heat from the reactor to conventional steam turbines. The heat in the reactor is released by the fission of uranium-235, and this process yields more neutrons to create more fissionable uranium-235 and plutonium-239. Both these materials remain in the spent fuel when the neutron flux becomes so low that new fuel rods containing uranium-235 must be inserted in place of the old.

The nuclear fuel cycle as presently envisioned for such light-water reactors includes the refining of spent fuel to recover the fissionable uranium and plutonium for reuse. In the present "Purex" process these are recovered separately, which means that plutonium appears in purified form, a ready temptation for theft and di-

version.

An alternative reprocessing system is now being studied. A "nitriding" process would bring plutonium out of the spent fuel locked with some other wastes in a mixture not easily refined; the plutonium would thus be foreclosed to would-be militarists and terrorists while much of the unused uranium would be available for recycle.

The Tandem Cycle

While the U.S. has concentrated on light-water reactors, the Canadians have opted for the CANDU — a reactor which uses heavy water (in which the normal hydrogen atom of water is replaced by the heavy isotope deuterium) as moderator. Heavy water absorbs far fewer neutrons than "normal" water, and so this heavywater reactor has the advantage of producing about twice as much energy for a given weight of uranium as the light-water design. On this advantage the "tandem" cycle has been conceived. For it may turn out that the spent fuel from a light-water reactor can be effectively used in a heavy-water reactor of the Canadian design. The spent fuel from a CANDU reactor contains so little uranium that there would be "little justification" for reprocessing of any kind, says Thomas D. Davies of the U.S. Arms Control and Disarmament Agency.

Dr. Davies says that the "tandem" cycle — fuel used first in a light-water reactor then used in a heavy-water reactor — has one outstanding virtue from a nonproliferation point of view. "Plutonium would remain in its safest form — never separated from the highly radioactive spent reactor fuel — throughout the cycle," he told the American Association for the Advancement of Science last winter. Only the basic engineering problem of repackaging spent fuel from light-water reactors for use in the CANDU reactor remains to be

solved.

Co-processing and Denaturing

Another alternative is "co-processing" —the idea that reprocessing of spent fuel from light-water reactors can be done in such a way that plutonium and uranium are brought out of the wastes together, not individually, in a ratio of about one plutonium to 100 uranium. Such a plutonium-uranium mixture would directly fuel the CANDU reactor, but for light-water reactors some enriched uranium would have to be added. The uranium-plutonium mix is useless for weapons production, separating plutonium from it would require sophisticated technology, and the low plutonium/uranium ratio would guarantee that any covert diversion would involve large amounts of material, easily detected by international inspectors.

A fourth possibility is to substitute thorium for some uranium in what is called by its advocates, Theodore B. Taylor and his colleagues at Princeton's Center for Nuclear Policy Alternatives, a

"denatured" fuel cycle.

In this case, light- or heavy-water reac-

tors would be operated on fuel consisting of one part fissionable uranium, eight parts "natural" uranium-238, and at least 20 parts thorium-232. The thorium is "fertile" — it transforms into fissionable uranium upon capturing a neutron, just as uranium transforms into plutonium-239. But unlike plutonium, fissionable uranium is not separable chemically from uranium-238 and is therefore not convenient for making explosives.

The thorium "denatured" cycle does not entirely eliminate plutonium; some would be created by neutron capture in uranium-238, but it would be "substantially less" than in present cycles and it would be easily converted to uranium-

233

Professor Taylor says a decade may be needed to evaluate this "denatured" thorium cycle. But in the end, even this alternative, he thinks, may be academic: "Perhaps the world will have to experience disastrous changes in climate caused by too much carbon dioxide in the atmosphere, or wars over deposits of coal or what is left of oil and gas, or nuclear violence made possible by inadequately safeguarded stockpiles of plutonium, before we realize that the form of energy that has served humanity so well in the past [solar energy] is our best hope for the future." — J.M.

## Old Nukes Never Die (Well, Almost Never)

It's an irony. The high-level nuclear wastes which are the subject of so much debate eventually will be stored far from the populations who are so worried. But an overlooked source of nuclear radiation—the worn-out nuclear plant from which the wastes came—will sit prominently for centuries on prime bits of real estate near population centers.

A recent study of the costs of decommissioning large power reactors predicted that the reactors would have to remain at their sites for at least a century before the decay of cobalt-60 in the reactor structure permitted economical direct dismantling. According to the National Environmental Studies Project report, the total costs of closing a nuclear plant, guarding it for a century or more, and dismantling it come to about \$13 million, or around 2 per cent of the construction cost of a plant.

The study, sponsored by the Atomic Industrial Forum, considered five possible scenarios for treatment of a decommissioned nuclear plant after its 40-year use-

ful life:

 mothballing by securing the plant and posting a continuous guard;

- entombing by welding shut all en-

trances, sealing with concrete and installing alarm systems;

prompt removal and dismantlement;
a combination of mothballing for 100 years, followed by dismantlement; and
a combination of entombment for 100 years, followed by dismantlement.

Permanent mothballing or entombment until a totally safe radioactivity level was reached would require the passage of up to half a million years, the study found. This is because nickel-59 and carbon-14 produced by nuclear bombardment of the metal structures are extremely long-lived isotopes.

Prompt dismantlement would cost about twice as much, the study said, in part because of the remote manipulation techniques required by the high radioactivity levels. While such immediate dismantlement is possible, it would produce higher occupational radiation exposures than would the century-later dismantling.

The choice of entombment versus mothballing would depend upon whether another power plant was to be sited near the decommissioned plant. If so, the same guard force could monitor both the new and the decommissioned plant, and a simple mothballing would be most economical. If not, the more secure entombment would be preferable.

The nuclear industry would clearly prefer simply to seal their old nuclear plants to await their cooling down, but whether the political climate would allow a hundred-year waiting period is another

matter. — D.M.

# Geologists View Nuclear Power

When Roman generals triumphantly entered a captured city, they retained by their sides oracles who whispered portents of doom to remind them of the mutability of their glory. Today's engineering geologists are playing much the same role as sidekicks to energy planners who glorify the coming age of nuclear power. As more and more power plants are planned, the geologists muse darkly over fuel availability, mining, siting, and waste disposal problems surrounding the transition to nuclear power.

Geologists have become the "global clean-up people" of an impending nuclear age, said one geologist at the American Association for the Advancement of Science in Denver this winter. If nuclear power undergoes the large increase expected, geologists will have too little time to solve the problems which now loom so

arge.

First of all, the actual uranium supply is in doubt, said Earl Cook of Texas A & M University. Estimates of available uranium resources have been made assuming that a market price of \$30 per pound will lure 1.3 billion tons from the ground. But only

a third of this amount lies in proven reserves; the rest lies in the nether region of "potential reserves." We need far more accurate predictions than that, said Dr. Cook. The supply on hand is the critical issue in determining whether or not to recycle plutonium, and whether to accelerate development of the breeder reactor. The full use of breeders could increase the energy available from existing uranium supplies by 300 times, and total recycle of plutonium would increase the amount of available energy by 50 times, he said.

If the U.S. decides neither to allow the breeder to be installed, nor to allow plutonium to be recycled in light-water reactors, "the remaining uranium resources will be equivalent only to the remaining natural gas in energy content,"

said Dr. Cook.

Whatever the amount under the ground, capabilities for mining and processing the uranium suffer from their own limitations. Four of the five refineries in North America that refine uranium concentrate into uranium hexafluoride — the feed material for enrichment plants —were built in the 1950s, said R. G. Dakars of Canada's Eldorado Nuclear, Inc. Since it now takes seven to nine years to develop conventional mine-mill facilities, and at least five years to arrange for siting, licensing, and construction of new refineries, newly-built reactors may be caught fuel-short in the next 15 years.

In addition, there is a shortage of skilled miners who are willing to spend time in the dangerous and often remote uranium mines. Canadian miners at the bleak Rabbit Lake mine in northern Sasketchewan now fly 450 miles to work seven-day shifts. Such programs are expensive, but may be the only way to attract skilled labor to these sites, said Mr. Dakars.

Mining health and safety issues are difficult to resolve, as well, because of the emotional atmosphere over radiation and anything nuclear, he said. Standards to limit the allowable inhalation of dangerous radon daughters - alpha emitting solids that are an occupational hazard of miners - have yet to be determined. At the processing site, tons of milling wastes containing low levels of radioactivity grow into large heaps. The effects of these radioactive tailings on the nearby environment and on those who live near these sites are also in doubt. Due to these problems, financial and technical, development of new facilities may be too slow during the critical growth period of the next decade, Mr. Dakars said.

Many hard-to-predict geologic and seismologic factors also dog power plant siting experts. While enough is known of active faults to impose bans on power plants proposed in some areas, such as the abandonment of plans for a new reactor in California's Bodega Bay on the San Andreas fault, estimating the potential activities of older, quieter, and smaller faults remains a headache for planners. En-

# Nuclear Power in 20 L.D.C.s by 2000?

Rapidly increasing energy demand and growing reliance on nuclear power will characterize the world's developing nations in the last quarter of the 20th century. Indeed, at least 12 — and perhaps 16 — developing nations will likely operate nuclear power plants by 1990, and three more may be added to the list in the next decade, says Alan M. Strout, Research Affiliate of the M.I.T. Energy Laboratory.

While population in the non-O.P.E.C. developing countries may have doubled by the year 2000 and their gross domestic product have increased by a factor of four, their total energy consumption will increase by 5.4 and electricity con-

sumption by 6.5.

To meet this prodigious new demand, says Dr. Strout, most major developing countries will turn to nuclear power; according to his economic analysis, a developing country will find nuclear power fully competitive with oil "even under fairly conservative assumptions" for plants of 600 megawatts or larger with the price of oil at \$11.40 per barrel. With somewhat less conservative assumptions, nuclear plants as small as 250 or 300 megawatts become feasible at today's oil prices.

According to Dr. Strout's analysis (which is considerably more conservative than that of the International Atomic Energy Agency), 19 per cent of the total installed generating capacity (396,000 megawatts) in those developing countries "with nuclear potential" will be filled by nuclear power in 1990. A decade later, nuclear power will be responsible for 36 per cent of those countries' electric consumption, which by then will have more than doubled to just under

800,000 megawatts.

In 1990 the members of the "nuclear club" will include India, Pakistan, Taiwan, Korea, Iran, Turkey, Egypt, the Philippines, Mexico, Brazil, Argentina, and Venezuela—and possibly Thailand, Singapore, Colombia, and Indonesia. By 2000 the list should include Hong Kong, Peru, and Chile. The list could be doubled if small-size nuclear plants—below 600 megawatts—become readily available at lower cost or if countries choose to ignore marginal economic disadvantage to gain strategic or political advantage..—J.M.

#### SOFT ENERGY PATHS Toward a Durable Peace

Amory B. Lovins, Friends of the Earth, Inc. (Published for Friends of the Earth, Inc.)
Based on his 1976 article in Foreign Affairs—which Energy Daily called "a seminal chapter in the history of energy policy"—Mr. Lovins proposes a coherent non-nuclear energy policy. This book, for the first time, ties all the issues together—engineering, economic, and thermodynamic concepts are thoroughly but concisely treated along with the social, environmental, and political perspectives.

In preparation

ca. \$15.00 (cloth) ca. \$6.95 (paper)

#### NUCLEAR POWER ISSUES AND CHOICES

The Nuclear Energy Policy Study Group, Spurgeon Keeny, Jr., Chairman Foreword by McGeorge Bundy (Published for the Ford Foundation) Prepared by a distinguished group of sci-

entists and economists, this report is a comprehensive analysis of nuclear power economics. Setting aside "optimisitc" assumptions about the potential savings of energy conservation, it concludes that our economy can provide adequate energy in the future without major social or economic changes. \$16.50

#### ENERGY FUTURES

Industry and the New Technologies Inform, Inc.

A meticulously compiled summary of technical information on how American corporations are developing and commercializing new energy sources. Using concise and nontechnical prose, the report profiles over 200 major R&D projects of 142 firms in 17 new technology areas. (Published by Ballinger for Inform, Inc.) \$45.00

#### MANAGING THE ENERGY TRANSITION A System Dynamics Search for Alternatives to Oil and Gas

Roger F. Naill, Thayer School of Engineering, Dartmouth College

Written in clear, non-technical language, this study uses a mathematical model (COAL 2) to evaluate strategies designed to achieve independence from foreign sources of oil, Volume I offers the technical data and assumptions of COAL 2 and Volume II describes the actual model.

Volume I \$20.00 Volume II ca. \$20.00

# FROM GUNS TO BUTTER Technology Organizations & Reduced Military Spending in Western Europe Bernard Udis, University of Colorado

Bernard Udis, University of Control How high technology organizations—particularly aerospace, electronics and nuclear facilities—cope with declining defense budgets—includes an analysis of the nature of the military market for high technology systems; effects of arms exports and government policies in support of civil science and technology; and the role of international relations.

In preparation ca. \$16.50

#### STALEMATE IN TECHNOLOGY

Gerhard Mensch, International Institute of Management, Berlin

Originally published in Germany, this much acclaimed book links worldwide economic cycles—periods of growth and affluence as well as periods of recession—with innovations (or the lack of innovation) in technology. It offers convincing evidence of the need for constructive government policies which encourage research and development of basic innovations in new areas.

In preparation ca. \$15.00



gineers can excavate along known faults and cracks to determine where reactors might safely be built, but this is time consuming and costly, and discourages potential investors, said James Devine of the U.S. Geological Survey.

The major question in all the geologists' minds, however, is how to dispose of radioactive wastes from the power plants. The E.P.A.'s G. Lewis Meyer said that the problems so far in underground disposal of low-level nuclear wastes - used and discarded equipment and clothing from plant maintenance, for example - are "correctable or avoidable," but he also sees the sheer volume of low-level waste that will be generated in the next 15 years causing as yet unimagined bottlenecks. He envisages at least 150 truckloads of lowlevel waste being delivered to each disposal site daily. Alternative treatment methods would help reduce the volume, he said.

Ernest E. Angino, University of Kansas geologist, recommends burial of dangerous high-level waste, which remains radioactive for thousands of years, in geographically isolated salt deposits. Most important, he says, is to avoid areas where subsurface water can encroach and leach radioactive contaminants from the disposal site into the surrounding area. While the acreage that will be required is not large — he foresees solidified high-level wastes covering an area about the size of a football field 12 to 13 feet deep by the

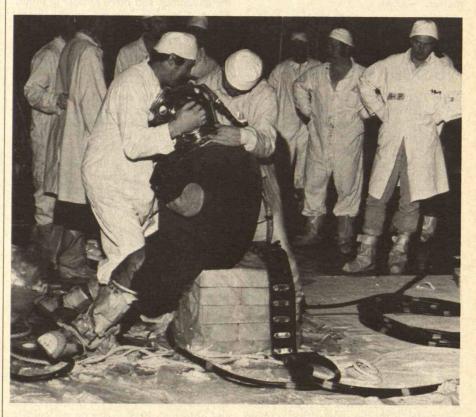
year 2000 — most of the surrounding rocks will react to resulting high temperatures and radioactivity. Water migrates toward areas of higher temperature, a phenomenon that can inadvertantly bring deep ground water into contact with the disposal area.

Not all countries contain within their boundaries rock deposits of sufficient geologic and thermal stability to bury wastes. He suggested the need for an international policy for waste management, but wonders if those countries with a stable geologic environment will be willing to accept the amounts of nuclear waste generated in other countries for burial. The political and emotional responses to the problem so far make this unlikely, he said.

The alternative is to study possible disposal of high-level nuclear wastes under the sea and in the Antarctic ice sheet, but geologic knowledge of the behavior of these areas when exposed to long-term radiation makes these alternatives doubtful in the short term, he said. — S.J.N.

# Core Corps

The hard-hat diver dons his helmet with the help of an attendant, clumps over to the ladder and carefully descends into the water. The job is a piece of cake — water visibility is excellent, lighting is good, working depth is shallow, and the struc-



Nuclear plant technicians prepare a diver for repair work in the nuclear core of the Connecticut Yankee power plant. According to power plant operators, divers can effect repair and maintenance chores far more quickly and inexpensively than is possible with remote manipulation devices. (Photo: Northeast Utilities) ture to be repaired is clean and barnaclefree. The only fact that might give one pause is that this diver is doing his job deep in the bowels of a nuclear power plant, surrounded by water at up to 110°F containing radioactive elements.

According to a recent article in *Electrical World*, divers have performed more than 30 repairs in the water-filled reactor cavities of nuclear power plants in the Northeast over the past few years, saving time and money over the usual remote control repair method using television

cameras and manipulators.

Operations which may have taken days or weeks by remote control have been performed in minutes or hours by divers, according to the article, and thus far they have had no problems with radiation exposure. In addition to saving time on the repairs, power plant operators save thousands of dollars on the remote repair equipment that would normally have had to be discarded after use in the reactor's central core.

To perform repairs, power plant technicians first shut down the chain reaction and remove the fuel. A pair of divers in specially sealed "dry" suits then enter the reactor to replace or adjust the faulty core components. Once repairs are completed, the divers emerge from the water, and are decontaminated and debriefed by the engineer in charge. Plant radiation experts then measure the total body radiation the diver has been exposed to before clearing him. So far, exposures have been found to be well below the permissible limits for

nuclear plant workers.

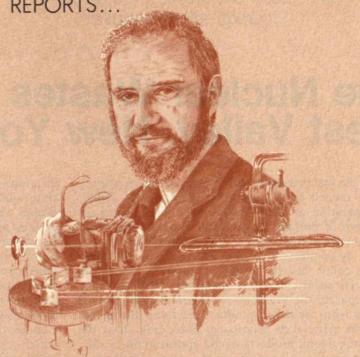
The first such dive was carried out at Yankee Atomic Electric Co.'s Rowe, Mass., plant. The replacement of shrouds for the nuclear plant's control rod had to be done underneath the core, an extremely difficult place for remote manipulators to reach. After developing special procedures for diving in the core, one diver from Underwater Construction Corp. of Essex, Conn., and one from the power plant completed the work in about three hours. Plant managers estimated that the project had saved about 60 ten-hour shifts and would have involved a 30-day shutdown

of the plant.

The only major problem has been keeping divers cool in the warm water, and this has been solved by a special cooling garment, loaded with crushed ice. As power plants meet new repair problems, the use of divers will spread, it has been predicted, and local diving clubs may hear tales of a totally new kind of underwater adventure.

-D.M.

MATERIALS RESEARCH CENTER REPORTS...



# On CARS Spectroscopy

The acronym, CARS, means <u>C</u>oherent <u>A</u>nti-Stokes <u>R</u>aman <u>S</u>cattering. Some advantages of the method in comparison with ordinary Raman spectroscopy are 1) high scattering efficiency, 2) coherent collimated signal, 3) no interference from fluorescence, 4) high resolution, 5) no analyzing spectrometer needed if the input frequencies are known.

A CARS signal is generated by illuminating a sample with two laser beams whose wavelengths differ by an amount equal to a Raman wavelength shift in the sample. The signal results from the non-linear mixing of the two input beams. It is a coherent beam of light so it may be transmitted without attenuation over long distances.

Following work done elsewhere with pulsed CARS, the first observations using low-powered continuous lasers were made at the Materials Research Center a few years ago. Methane gas was illuminated with green and red light and low-intensity-blue CARS light was observed.

Quite recently, Dr. J.J. Barrett first observed CARS from the rotational levels of hydrogen molecules. The signal is stronger than for the vibrational levels because the scattering probability is greater and the linewidth is smaller.

Possible applications of CARS are: analysis of flames, stack gases, engine exhausts, and the products of photochemical reactions.

Allied Chemical Corporation/Materials Research Center P.O. Box 1021R, Morristown, New Jersey 07960



Richard K. Lester Visiting Research Fellow Rockefeller Foundation David J. Rose
Professor of Nuclear Engineering
M.L.T.

# The Nuclear Wastes at West Valley, New York

In 1966, the first private nuclear fuel reprocessing plant in the U.S., owned by Nuclear Fuel Services, Inc. (NFS), began operation at West Valley, New York, some 30 miles south of Buffalo. Its principal function was to recover uranium and plutonium in pure form from fuel irradiated in commercial power reactors, so that these materials could then be re-used in fresh reactor fuel. A series of chemical extraction operations at West Valley would separate the uranium and plutonium from each other and from the fission products produced during fuel irradiation. After such processing, practically all of the non-volatile fission products would appear in one acidic, highly radioactive, aqueous waste stream discharged from the reprocessing plant.

Over 600 metric tons of fuel was reprocessed at West Valley from 1966 to 1971, producing 600,000 gallons of liquid high-level waste. A small portion of this (some 12,000 gallons) now resides in a stainless steel tank, and arose from reprocessing a single consignment of thorium-based fuel. Most of the waste, however, was generated during uranium fuel reprocessing. Unlike the thorium waste, which was retained in nitric acid solution, this waste was neutralized with sodium hydroxide immediately after generation, and is now stored in a single

750,000 gallon carbon steel tank.

The neutralization of high-level waste causes the precipitation of an insoluble sludge, containing almost all the radioactive fission products, except for cesium, which remains in solution. It is estimated that 85 per cent of all the radioactivity in the carbon steel tank at West Valley is contained in about 30,000 gallons of sludge at the bottom. These are only estimates, because the exact arrangement and composition of the sludge is not known. No satisfactory way to remove the sludge has been developed; it cannot be re-dissolved in nitric acid without dissolving the tank also. Furthermore, steelwork protruding into the sludge from the tank floor will interfere with attempts to remove the sludge hydraulically or mechanically; access to the tank is limited to a few small holes in the roof, and the sludge itself is, of course, highly radioactive. Yet the waste cannot be left indefinitely in its present form because the carbon steel tank will eventually corrode. Whether some permanent accommodation could be found in situ, whether the main waste inventory must be removed from the site by schemes as yet unspecified, and who will pay for the operation, for which guesses have run as high as 600 million dollars, now become a topic of lively debate.

As for the West Valley plant, it closed in 1972 for mod-

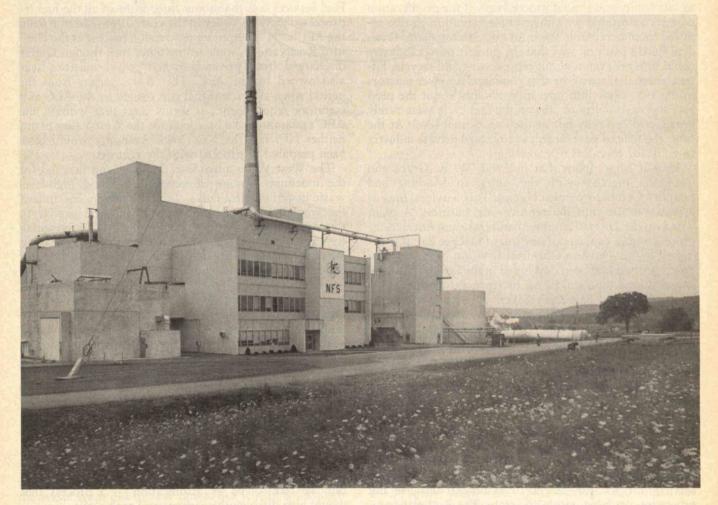
ifications and enlargement. Nuclear Fuel Services has since announced that it does not intend to reopen the facility, and has given as its reason the cost of meeting various seismic requirements imposed by the Nuclear Regulatory Commission, and unforeseen in the 1960s. But this reason must be weighed in the context of many other circumstances, to be described shortly. These circumstances provide opportunities to blame the various participants: NFS itself; the Getty Oil Company, which now owns a controlling interest in NFS; W. R. Grace and Company, which started the venture; New York State, which encouraged it; the U.S. Federal Government, which, through the (then) Atomic Energy Commission, provided technological information, a license to operate, and fuel reprocessing contracts without which the venture would have been economically unviable; and nuclear power in general, for producing apparently ineluctable and intolerable problems.

Such criticisms would be uncharitable, but seldom entirely groundless. All concerned made enough mistakes that we cannot assign unique technological or institutional blame, nor shall we try. It is more constructive to look ahead, toward what might be done to ameliorate the situation. Nevertheless, West Valley has significance in the broader context of the development of the U.S. nuclear power industry; and if the problem created there is to be understood, one must recapture the mood of the early 1960s, when nuclear power seemed to have few problems, and was hailed as the answer to resource depletion and environmental pollution. The fundamental mistake was one of inadequate technology assessment,

both at the time of inception and thereafter.

It is important to be clear about the nature of the West Valley problem. On the one hand, the waste and its method of containment differ from those likely to be found in any future fuel reprocessing venture; specifically, tanks will be made of stainless steel, and the high-level waste will be retained in acid form. Carbon steel is cheaper than stainless, but cannot be used to contain acidic waste. On the other hand, the West Valley problem more closely resembles and is a modest harbinger of the vastly larger problem of the nuclear weapons waste at the Hanford Reservation, near Richland, Washington, and at Savannah River, South Carolina. Here, fuel reprocessing has been carried out and continues to take place at government facilities, primarily in connection with the production of plutonium and other materials for nuclear weapons, in programmes dating back to World War II. This waste, in much greater volume than at West Valley,

Six hundred thousand gallons of high-level radioactive waste lie in a tank that will eventually corrode. What should be done? And who should be responsible for doing it?



The Nuclear Fuel Services reprocessing plant at West Valley, New York, closed since 1972. Between 1966 and 1972, over 600 metric tons of spent nuclear-reactor fuel were processed here; the plant was the only privately-owned facility of this type ever to operate

has also been neutralized and stored in carbon steel tanks. Unlike the West Valley situation, much of the weapons waste that did not originally precipitate as a sludge has been solidified to form a salt cake in the tanks. Cleaning those Augean stables might cost 20 billion dollars or more.

We shall not discuss the weapons waste problem per se, except as it directly bore on how the NFS project developed; we shall discuss the West Valley problem both technically and institutionally, and outline some reasonable approaches toward amelioration of it.

in the history of the U.S. nuclear age. The only notable feature visible in the photograph is the high stack, from which gaseous radioactive waste was vented after treatment. The stations along the height of the stack are radiation monitors.

#### How the Problem Arose

The military research programs of the Second World War brought in their train the development of peaceful uses of nuclear energy. In some respects, that train is still arriving. Until very recently, a "closed" nuclear fuel cycle was universally regarded as essential to a mature nuclear industry. That is, not only was fuel to be made from freshly mined and enriched uranium (as is done today), but also the used fuel was to be reprocessed to recover its fissionable plutonium and uranium content; these latter were to be recycled and combined with the "fresh" uranium for

use in new fuel. No industry for reprocessing commercial fuel exists in the U.S. today, so the nuclear fuel cycle has yet to be closed. Still, the technological feasibility of plutonium and uranium recovery from used fuel does not appear to be in serious doubt. Large scale demonstrations of the technology have taken place both in the U.S. and elsewhere. Included amongst these must be counted the AEC (and now the ERDA) program for producing plutonium for nuclear weapons, which certainly involves at least partial fuel cycle closure. Obstacles to the closure of the commercial fuel cycle center on socio-political, environmental and economic issues rather than the question of technical feasibility.

In a major nuclear policy statement released shortly before the recent elections, President Ford directed that reprocessing and plutonium recycle should not be regarded as inevitable, and should proceed only if the proliferation dangers associated with their implementation can be reduced to an acceptable level. An important tenet of President Ford's position was that the nuclear power industry could prosper even without reprocessing and recycle. Fifteen years ago, when the first commercial power reactors in the U.S. came into operation, doubts about the need for, and desirability of closing the fuel cycle were rarely heard, and certainly not at the Presidential level. At the time, the federal government encouraged private industry to go in for chemical reprocessing.

Thus it came about that in 1962, W. R. Grace and Company together with the American Machine and Foundry Company formed Nuclear Fuel Services, Inc., as a joint venture into the reprocessing business. A plant based on the Purex (Plutonium and Uranium Extraction) process with a capacity of one ton of fuel per day was designed by the Davison Chemical Division of Grace. The Purex process had been developed in the U.S. by the AEC and was used (and still is) for its reprocessing operations at Richland and Savannah River. It remains today the most favored process, both in the U.S. and abroad.

NFS considered a number of sites for its plant. A major influence bearing on the final decision was the State of New York's eagerness to participate in the development of nuclear power in general and of chemical reprocessing in particular. The State Legislature, having determined that nuclear energy would benefit the state's economy, formulated policy to encourage its development. Thus the New York State Atomic Research and Development Authority was created in 1962. It was authorized, inter alia, to conduct research and development in areas related to the production and use of nuclear energy, and to provide services for nuclear power development and use not otherwise available within the state. The Authority proceeded to acquire, in the name of the state, a site known as the Western New York Nuclear Service Center at West Valley, one of whose functions was to provide a location for high-level waste storage facilities. (At that time, federal regulations required that such storage facilities be located only on land owned by a state or the federal government.) NFS leased part of it from the Authority and constructed its plant at a cost (to NFS) of \$32 million. In addition, the Authority had allocated a total of \$8 million of state-appropriated funds to the project. Some of this had been used in the original site purchase, and the remainder provided for the development of site utilities and the construction of facilities for receiving spent fuel and storing radioactive waste. The fuel and waste storage facilities were to be managed by NFS.

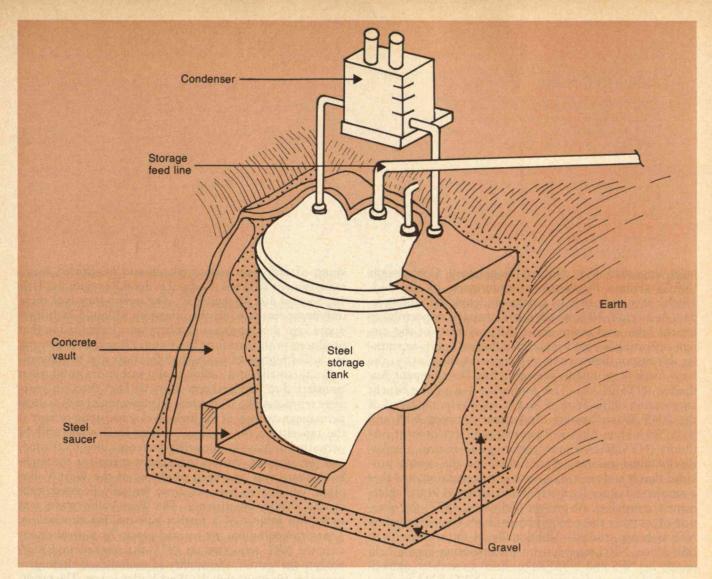
Federal involvement in this venture was both promotional and regulatory. The AEC had given assurances to all reactor operators that their reprocessing requirements would be met at AEC facilities at firm prices until 1967, unless private reprocessing capacity was established before then. However, in line with its policy of encouraging private participation in the reprocessing industry, the AEC preferred not to meet its obligation in this area if it could be avoided. A major obstacle to the development of private reprocessing was that the nuclear electric power industry - still at a foetal stage in the early sixties -could not supply enough used fuel to make it an attractive economic prospect. Thus the AEC offered to supply a substantial fraction of the NFS plant load for the first five years of operation. The outcome of the resulting Base-Load Contract of 1963 between the AEC and Nuclear Fuel Services was that about three-fifths of all the fuel reprocessed at West Valley in the years 1966-71 came from the AEC's "N" plutonium production reactor at the Hanford Reservation. (Some of the other fuel, though largely discharged from privately-owned power reactors, was also owned by the AEC. This was a legacy from the period when all nuclear fuel was owned by the AEC as a statutory requirement.) It seems clear that without the AEC's guarantee of a base load for the West Valley plant, neither NFS nor the New York Authority would have been prepared to proceed with the venture.

The West Valley plant was designed and licensed for the indefinite storage of neutralized liquid high-level waste in carbon steel tanks. The tank design, and indeed the whole waste management system, were similar to those that had been developed at the AEC's Savannah River plant; and the choice of carbon steel for the main West Valley tank has led to most of the subsequent difficulty. To be sure, management of neutralized waste at Savannah River had not been particularly troublesome. Neutralized weapons waste had also been stored in carbon steel tanks at the AEC's Hanford Reservation; those tanks were of an earlier design, however - single-walled as opposed to the double-walled type constructed later at Savannah River and then West Valley — and already by 1963 some had corroded enough to leak radioactive waste into the surrounding soil. Improved tank design and construction practices at Savannah River and West Valley reduced the leakage problem to the extent that there has been one small release at Savannah River and none at West Valley. But a characteristic of the waste management at all three sites was, of course, the precipitation of insoluble, highly radioactive sludge which could only be redissolved by acidification — a process that

An alternative waste management system had been developed at another AEC chemical reprocessing facility at Idaho Falls, Idaho. Here the waste was retained in acidic form and temporarily stored as liquid in stainless steel tanks. After an interim period of storage, the liquid was withdrawn and converted to a white powdery solid by a process called calcination, and then stored in stainless steel bins. Despite the record at Idaho — no leakage and generally satisfactory waste management — much less experience had been gained by 1963 with this system than with the neutralization/carbon steel method. Furthermore, stainless steel storage is much more expensive than carbon steel. For these reasons, a neutralized waste system was selected and licensed at West Valley.

would also dissolve the carbon steel tank walls.

Nevertheless, it was known that the carbon steel tanks



Schematic diagram of the high-level waste storage tank at West Valley, New York. A condenser removes the heat generated by radioactivity. The tank itself is of double-walled carbon steel construction; as yet, it shows no sign of leaking. But the integrity of any carbon steel tank for the long-term storage of radioactive waste is extremely suspect: at the Hanford Reservation in the State of Washington, several carbon steel tanks — of single-walled construction — have leaked a total of several hundred thousand gal-

lons of waste. The tank at West Valley would have to retain its structural integrity for at least one or two thousand years if the waste now within it is to be kept there. During that time the toxicity of the waste will diminish to a level comparable to that of pitchblende, a uranium-containing mineral. After about ten thousand years, the toxicity would be comparable to that of the ore from which uranium is mined.

would not last forever, and that long-term storage of neutralized liquid waste would require periodic transfer of the waste from old to new tanks. But it was not known how the sludge could be removed. Moreover, there were doubts as to the acceptability of liquid storage as a longterm management method, and activities were underway aimed at waste solidification and immobilization, thereby reducing the burden on future generations created by indefinite liquid storage. The most advanced of these — the Idaho solidification process - could not be used, however, because the high sodium content of neutralized waste prevented satisfactory calcination. In a nutshell, the high-level waste management philosophy at West Valley was a temporizing one: the system was adequate for the time being, and it was felt that something would turn up before long. Whatever the rationalization, the choice of neutralized waste storage in carbon steel tanks was a costly mistake.

When was this mistaken storage method first recog-

nized and understood by some cognizant authority? We do not know, but certainly the AEC realized as early as 1963 when West Valley was begun, that difficulties would lie ahead. Why then did the problem not receive public attention? The AEC had classified information about the total amount of radioactivity in the Richland and Savannah River wastes, on the basis that this information would aid foreign powers to assess the U.S. weapons programme. Although other information was not classified, the AEC generally responded to queries as briefly as possible, and volunteered even less. These circumstances minimized external knowledge about the problems, and provided an untroubled climate in which the West Valley plant was planned, built, and operated.

#### Recent Developments

When Nuclear Fuel Services in late 1976 declared its intention not to reopen its reprocessing plant at West Valley, it cited as a principal circumstance its inability to

meet upgraded U.S. Nuclear Regulatory Commission (NRC) seismic requirements (unforeseen in the mid-1960s) at a price that its customers would be willing to pay. As a result, NFS, which bears custodial responsibility for the high-level waste under the provisions of the current operating license for the installation, wants to transfer this responsibility to its co-licensee in the venture, the New York State Energy Research and Development Authority (NYSERDA). The Authority is a public benefit corporation of the State of New York. Under the terms of the 1963 Waste Storage Agreement between NFS and New York State Atomic Research and Development Authority (NYSERDA'S predecessor as co-licensee), the Authority must assume responsibility for the waste, provided that it and the tanks are in good condition, and that a number of other legal requirements stated in the agreement are satisfied. At present (February, 1977) the question of whether these requirements have been satisfied by NFS is being studied. Additionally, if the transfer is to take place, NRC must amend the operating license held jointly by NFS and NYSERDA. Prior to such an amendment, NRC must determine whether NYSERDA is capable of assuming custodial responsibility for the waste, a responsibility that involves, according to the Waste Storage Agreement, the "perpetual operation, maintenance, surveillance, replacement and insurance" of the high-level storage facilities. NYSERDA has the option of using its own personnel to operate the waste facilities, or alternatively the work could be done by NYSERDA contractors. The Agreement does not directly address the issue of responsibility for converting the waste to a different form or transporting it to a different location, since the West Valley plant was designed and licensed to store it indefinitely as a liquid in tanks. Whether the transfer of responsibility for the waste management functions that are defined in the Agreement can properly take place without consideration of these key questions may be a point of contention. The Sierra Club and local interest groups may intervene in the NRC's license amendment proceedings.

At this point we review more fully the NRC's responsibilities for the West Valley high-level waste. They fall into two categories: rule-making, whose function is to define a waste management policy; and licensing of the actions taken to implement that policy, together with the monitoring and enforcement associated with licensed activities.

NRC is responsible for developing a rule for long-term storage of the West Valley waste. In 1970, the regulatory arm of the AEC announced a new policy relating to the siting of fuel reprocessing plants and associated waste management facilities (Code of Federal Regulations, Title 10, Section 50, Appendix F). The new policy had these important features: (1) the inventory of liquid high-level waste kept at a reprocessing plant must be limited to that produced in the previous five years; (2) within five years, the liquid high-level waste shall be converted to a chemically, thermally and radiolytically stable dry solid, then transferred to a federal repository no later than ten years after reprocessing; (3) the federal government will assume permanent custody of the high-level waste upon receipt at the repository; (4) disposal of high-level waste will be permitted only on land owned and controlled by the federal government. An exception was made for the highlevel waste that had been produced at the West Valley plant, which was then, as now, the only licensed commercial facility in existence. The West Valley waste was to be the subject of a further rule-making proceeding. That proceeding has yet to take place. As a preparatory step, the NRC requested (in 1975) that the federal ERDA analyze the technical feasibility of a number of alternative processes for managing the West Valley waste. The resulting report, prepared by Battelle Pacific Northwest Laboratory ("Alternative Processes for Managing Existing Commercial High-Level Radioactive Waste," NUREG-0043, 1976, published by the U.S. Nuclear Regulatory Commission), studied only those processes that ERDA had been considering for the management of its own plutonium production waste at Richland and Savannah River. In view of the close similarity between the two waste types this was a legitimate initial constraint. However, it was acknowledged at the time that other alternatives, not considered for ERDA's waste (and therefore not included in the Battelle study) could be applicable to West Valley.

The Battelle study constitutes part of a data-gathering phase in NRC's development of a rule for long-term storage of the West Valley waste. The strategy would then continue by weighing the available alternatives, and finally by formulating a rule, with public involvement at each stage of the process. In more detail, NRC officials anticipate that the set of options considered by Battelle would be expanded and evaluated more fully in a Draft Environmental Statement specifically directed to the formulation of a provisional rule. A period of public comment on the draft statement would follow, after which a Final Environmental Statement would be prepared. This would provide the principal input to a rule-making hearing, whose outcome would be the final rule. It has been

estimated that the entire proceeding would take about two years, although at this stage, and in the present climate of procedural prolixity with respect to nuclear regulation, all estimates must be regarded as highly uncertain.

With respect to its licensing responsibility, the NRC must first ensure that the high-level waste is adequately maintained, guarded and monitored. Eventually it must license the decontamination and re-use or decommissioning of the entire West Valley site, including the reprocessing plant and all the waste facilities.

We now turn to the most recent activities of NYSERDA, to which NFS proposes to transfer responsibility for the waste. NYSERDA is currently involved in the effort to establish whether legal requirements for the transfer have been met. At the same time, the chairman of NYSERDA, on behalf of the Authority and the state, asked ERDA to assume this responsibility on the grounds that the federal government had a major role to play in events leading to the present situation, and that ERDA is the logical federal agency to undertake the task.

At the time of writing (February, 1977), the federal ERDA has responded to this request only by repeating its earlier offer to provide technical assistance in developing an acceptable method of waste management. ERDA officials say that this should not be interpreted as a refusal of responsibility, since the next step in the affair necessarily involves the additional technical analysis that ERDA is willing to provide. But, they argue, allocation of the responsibilities that are being urged upon ERDA cannot be determined so casually.

Somewhat parenthetically, it is interesting to contrast the temporizing character of the early West Valley waste management decisions with the current pressures for a "demonstration" of the technology for treatment and long-term storage of high-level waste as quickly as possible — a demonstration, moreover, that is demanded by many as a necessary condition for the continued growth of nuclear power.

As the 1960s drew to a close, the regulatory requirements for nuclear fuel cycle facilities became increasingly stringent. We have already referred to the new policy on the siting of reprocessing plants and waste management facilities announced by AEC in 1970. Although the existing high-level waste at West Valley was exempted from those requirements, at least temporarily, it was clear that Nuclear Fuel Services, in which the Getty Oil Company had by this time acquired a controlling interest from Grace, would be obliged to manage its future waste in conformity with them. This meant constructing a sol-

idification facility at the site, which in turn meant replacing the neutralized waste management system with one capable of handling and storing acid waste, because neutralized waste was still intractable. Furthermore, emission standards for release of radioactivity from nuclear installations and standards for radiation exposure to operating personnel were also becoming stricter. When NFS closed down its plant in 1972, the alterations necessary to increase the capacity were to be accompanied by modifications designed to meet the upgraded regulatory requirements. Indeed, had NFS not voluntarily ceased operations, the AEC might have been obliged to shut the plant down on safety and environmental grounds.

In the years since 1972, uncertainties surrounding the major policy decisions affecting reprocessing have multiplied. Well before President Ford's October 1976 statement that institutionalized delay, the resolution of the plutonium recycle issue had been postponed on a number of occasions. There were uncertainties as to the nature of the safeguards that would be required at any facility handling plutonium in strategically significant quantities. Uncertainties also remained in the area of waste management. Although the AEC had announced in 1970 that it would only accept at a federal repository waste that was "chemically, thermally and radiolytically stable," that requirement was not precise enough to design a solidification facility. The NFS decision to abandon the fuel reprocessing business must therefore be seen in the context of all the uncertainties surrounding the future of reprocessing in general, and of West Valley in particular.

#### What To Do?

Resolution of the West Valley problem will require that two questions be answered: What is to be done with the waste? and Who is to be responsible? Studies of technical feasibility have so far identified two broad options. First, part or all of the waste could be disposed of in situ—that is, solidified in the tanks (probably as salt-cake by a technique similar to that developed and used at Savannah River and Richland). However, the permanence of the disposal is doubtful. Second, with much greater difficulty the waste could be removed from the tanks as a first step in a more thorough disposal process. After solidification, it might then be placed in a geologic structure underlying the West Valley site or alternatively it might be treated so as to conform with the impending requirements for all future high-level waste (within the next two years, NRC hopes to have developed solidification performance and Continued on p. 28

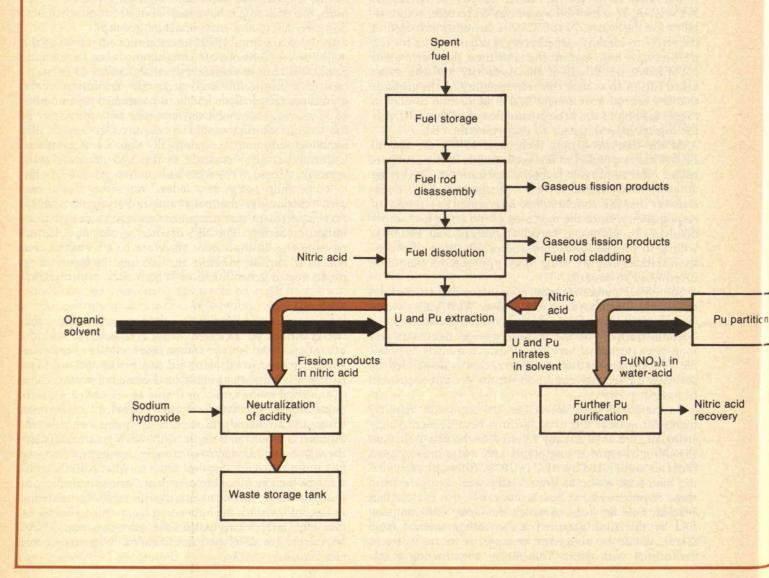
#### Fuel Reprocessing at West Valley

One cannot recover uranium and plutonium from spent reactor fuel by the use of a cocktail shaker — not even a cocktail shaker behind several feet of concrete shielding. The problem is that the recovery is complicated and has many stages, with streams of varying chemical composition — and varying radioactivity — appearing at each stage. Moreover, a large scale of operations is required if the proper mixing and flow is to be achieved among the solvents employed at several points. Despite these difficulties, fuel reprocessing has been considered valuable by some advocates of nuclear power, for uranium is growing scarce, and plutonium . . .

Plutonium has several possible uses, all of them problematical at present. In the first place, plutonium, like uranium-235, is fissionable, and could therefore be used as fuel for present-day commercial reactors. But uncertainties about its hazards both as a radiological poison and as a material divertable for illicit weapon-making have thus far precluded that use, except in small-scale experiments. Plutonium could also be stockpiled against a time when breeder reactors are built, for breeder reactors would require it as start-up fuel. But as these paragraphs are written, the Carter Administration, despite arguments that breeder reactors constitute one of the few options for long-term energy supply, is preparing to cut the funding for their development. The hazards of

plutonium appear to be the principal reasons. Finally, plutonium could be used by the U.S. military to make nuclear weapons. But the military demand is now small; evidently the current stockpile is sufficient for that purpose. In any case, the plutonium derived from reprocessing of commercial reactor fuel is not the mixture of isotopes most suitable for a bomb.

Whatever the arguments about plutonium and uranium, the reprocessing of reactor fuel has also entailed the creation of a third endproduct: concentrated radioactive waste — the content of the tank at West Valley, New York. A description of how this came about must begin with a description of reactor fuel itself: in light-water reactors, it is uranium oxide enriched in U-235, packed within tubes of zirconium alloy twelve feet long by three-eighths of an inch in diameter. Throughout each tube's tenure within the core of a power reactor, the U-235 nuclei within each tube are fissioning —that is, releasing neutrons and splitting into the nuclei of lighter atoms. The process produces energy, of course, but it also has several consequences for the unconsumed fuel. In particular, some of the neutrons freed by fission are absorbed by nuclei of the isotope U-238, converting them to the nuclei of plutonium. As times goes on, the fissioning of this plutonium contributes an ever-greater fraction of the total



energy production. But not all of it fissions. Some remains unchanged. Some absorbs additional neutrons, and metamorphoses into still heavier elements. Chief among them are americium and curium - both radioactive. As for the breakdown products created by the fission of U-235, these medium-weight nuclei comprise a large variety of elements. Most are solid, a few gaseous. Some are highly radioactive, some not at all.

In consequence of all the nuclear transformations occurring within it, the content of a fuel rod becomes increasingly tainted by impurities, both lighter and heavier than uranium and plutonium, during its time in the reactor core. When such a rod (actually an assembly of rods) is finally removed from the reactor, it is highly radioactive. Accordingly, after a few months of on-site storage to let the radioactivity and associated heat diminish by a factor of about 100, it is placed in a shipping cask and leaves the reactor site bound within this sarcophagus. In the case of rods sent for reprocessing to the Nuclear Fuel Services plant at West Valley, New York, it travelled by rail.

Its fate at West Valley is shown in the accompanying diagram. Upon arrival, it would be unloaded by remote control and placed in underwater storage - specifically, in that symbol of the nuclear age, a deep pool with a blue glow of so-

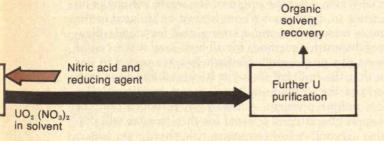
called Cerenkov radiation emanating from the bottom. The storage tank appears at the top of the illustration's vertical branch. All further processing would necessarily be conducted by remote control, with several feet of concrete intervening at all times between the radioactivity and any personnel at the plant.

The West Valley plant processed fuel by the Purex method short for "Plutonium and Uranium Extraction," and diagrammed in the illustration. The method begins with the disassembly of the fuel rod assemblies; that is, the fuel rods are removed from their arrays and then sawed or sheared - at West Valley they were sheared — into two-inch lengths. This causes a release of gaseous fission products, which at West Valley were released from a high stack. (Newer designs call for a reprocessing plant to retain most of the gaseous wastes). Upon shearing, the fuel-rod fragments drop immediately into a bath of nitric acid, which dissolves the fuel but not the cladding - the two-inch lengths of zirconium-alloy tube. The cladding is itself somewhat radioactive, and moreover a degree of radioactivity clings to it from the fuel material. After leaching to remove as much of the radioactivity as possible, the cladding is buried.

The dissolving of the fuel has liberated the remainder of the gaseous fission products. What remains to be processed is uranium, plutonium, and a multitude of fission products as well as heavy, transuranic impurities, all dissolved and commingled in nitric acid. The uranium appears as uranium nitrate, UO2(NO3)2, and the plutonium as tetravalent plutonium nitrate, Pu(NO<sub>3</sub>)<sub>4</sub>. Now begins the separation of the fission products and the transuranic impurities from the uranium and plutonium, and the further separation of the uranium and plutonium from each other. These steps are shown in the horizontal portion of the illustration. The crux of the first separation — that of the fission products and transuranic impurities from the U and Pu nitrates - is that both of the latter, though soluble in nitric acid, are more so in the organic solvent tributyl phosphate, diluted with kerosene. Accordingly, the nitric acid solution is made to flow downward through a long column, and the organic solvent is made to flow upward. The result, given sufficient mixing, is that the fission products and transuranic impurities, still in nitric acid solution, flow from the bottom of the column (they appear at the bottom left of the illustration, in the flow labelled in color). At West Valley, the nitric acid was neutralized by the addition of sodium hydroxide, and the resulting liquid, with a precipitate of sludge, stored in an underground tank — the subject of this article.

As for the uranium and plutonium nitrates, they have transferred to the organic solvent, and are shunted from the top of the column onward to further separative processes. To separate the U from the Pu, a counter-current flow similar to the first is employed. Here the crux of the separation is that tetravalent plutonium nitrate is soluble in tributyl phosphate, but trivalent plutonium nitrate — Pu(NO<sub>3</sub>)<sub>3</sub> — is not. The addition of a reducing agent serves to change the soluble form of the plutonium to the insoluble. That done, it remains only to institute a counterflow of nitric acid. The plutonium nitrate, now made insoluble in the organic solvent, passes back to nitric acid solution; the uranium nitrate remains in the organic solvent. Both elements pass onward to further

purification steps. — M.F.



repository acceptance criteria in substantial detail), and transported to a Federal repository.

Another variant of the second option has received less attention. Recall that the waste has a distinctly military character, and that the West Valley problem resembles those at Savannah River and Richland. The alternative is to remove the waste from the tanks, solidify it with the minimum possible effort compatible both with transportation safety and with any further treatment operations which it might subsequently undergo, and then transport it to one of the two sites where the much larger volumes of chemically similar military waste wait discontentfully. ERDA has recently announced a program in which, over the next two years, technical alternatives and environmental impact statements for long-term management of military wastes at Savannah River and Richland will be prepared.

The Nuclear Regulatory Commission will face a number of difficulties in developing the policy and rules for future management of the West Valley waste. In the first place, it is generally agreed that the extent to which the insoluble sludge can be removed from the carbon steel tank will not be known until the extraction is actually attempted. But any detailed regulatory policy for West Valley developed without this knowledge may be very unhelpful. For instance, suppose that the rule requires that all the high-level waste be shipped off-site to a Federal respository, and suppose it is later found that a significant amount of the sludge — a few per cent, say — cannot be removed from the bottom of the tank with normal recovery methods. In order to comply with the regulations, it might then be necessary to dismantle the tank and transport those sections contaminated with residual sludge to the repository. The risks posed by such an operation might be greater than those associated with disposing of the contaminated tank in some form at the West Valley site itself. But if a significant quantity of high-level waste were to remain at the site, then the argument for transporting the majority off-site would be weaker, and a reevaluation of the risks and costs might lead to a decision to keep all the high-level waste at West Valley after all, as the best among a set of miserable choices. In this activity, where understanding comes step-by-step, so should the decision-making, hence also the rule-making — a view that we will develop throughout this section.

A related problem is the future of the rest of the site. It seems unlikely that reprocessing will be revived there. A license for the decontamination and decommissioning of the reprocessing plant and waste handling facilities (including those for non-high-level waste) will ultimately be issued by NRC. The extent to which the future use of the site is constrained by the presence of these decommissioned facilities should presumably influence the policy for high-level waste disposal and vice versa. It is not clear to what extent, if any, the problem of decommissioning those facilities other than the high-level waste tanks has been considered. The lease held by NFS on the portion of the Western New York Nuclear Service Center in which these facilities are located is not scheduled to expire until the end of 1980. NRC officials state that the decommissioning question will be broached at that time. Such a delay, in which the technological goals for the high-level waste would apparently be settled before the decommissioning of the remainder of the site is even considered, would preclude an optimal assessment or resolution, unless it turns out that the constraint on the future use of the

West Valley site imposed by the least restrictive of highlevel waste management alternatives exceeds those imposed by the other decommissioned facilities. Such an outcome cannot be assured in advance, and we see no valid reason for delay in considering the general decommissioning problem as part of a holistic assessment.

Another difficulty facing NRC in its rule-making procedure is that the viability of some of the technical options depends on the resolution of a number of legal and political complexities surrounding the question of agency responsibility. The most obvious example would be the transportation of the West Valley waste to ERDA's Hanford or Savannah River sites for subsequent treatment and ultimate disposal there or elsewhere. Should NRC's consideration of this alternative (and therefore its entire rule-making proceeding) await resolution of the issue of federal responsibility in the matter? Or should the Commission assume that there are no a priori political or legal obstacles, and develop a rule based on its own assessment of the risks and costs of the various technological options? The difficulties posed by these questions can best be dealt with by recognizing that the questions themselves represent conventional institutional modes of thinking. They were wrongly phrased. We ask instead: Will any amount of advance rule-making by NRC, the Department of Transportation, the Environmental Protection Agency, or whomever, in the absence of adequate knowledge, but in the presence of demands for absolute security, help to solve the problem at all? No. — In essence, rules are for teaching and for repetitive action, not for learning. Cleaning up West Valley is an experiment, for which there are no good precedents. Our conclusion is that the operation must be conducted as such; the principle guidelines will be prudence, intelligence, resolve and a charitable view on risk-sharing.

What we propose has often been described as improvisational or incremental decision-making, and a pejorative cast has been put upon it. But such criticism cannot apply here, where insufficient understanding exists at the outset,

and where the problem is unique.

A related issue that might confront the NRC is one of perceived differences between the requirements for the West Valley waste and weapons waste or future commercial waste. That the origin of the waste will make no difference to those from whom it must be isolated in the future is inescapable, and a strong case for standardization of disposition methods for all high-level waste can be built on this proposition. Nevertheless, we persist in our view that the military waste at Richland and Savannah River and the "pseudo-military" waste at West Valley pose a unique problem. Accordingly, provided that the management strategies selected for these wastes will present an acceptably low long-term risk, there is no reason to insist that such strategies must conform exactly to whatever requirements are established for all other commercial wastes. Ad-hocracy it may be, but not, we emphasize, in the critical area of allocation of long-term risks.\* To put the matter another way: imagining now that there is only one way to proceed and that we know it in advance would be a mistake.

Finally, we ask how the responsibility for the future

<sup>\*</sup> Getting many federal, state, local and non-governmental groups to work this way will be a formidable task. Regulatory and bureaucratic procedures rarely achieve such flexibility, especially when the work is spread over so many political jurisdictions.

management of the waste at West Valley should be allocated. A decision could be made in the courts, with Nuclear Fuel Services, NYSERDA and the federal government (presumably ERDA) each advocating the others' responsibilities in the matter. Other interested parties could also be involved. This approach has several disadvantages. Chief among them is that it generates antagonism instead of fostering cooperation. A legal confrontation between the federal ERDA and the State of New York would surely present an unedifying spectacle, in light of ERDA's assiduous efforts to cultivate good relations with the states while it prepares its national program to select and develop sites for the final disposition of high-level waste. ERDA's embarrassment would probably be aggravated by the fact that New York appears on its list of potential locations for a federal waste repository. Another disadvantage of a judicial settlement is that it might take a long time, and could therefore inhibit the start of what is necessarily an experimental procedure anyway. We also note that the difficulty of allocating financial responsibility in advance is similar to the problem that the NRC will face in developing a wastemanagement strategy in advance. The cost of the operation will not be known with any certainty until it is underway. Furthermore, the cost will clearly depend on the outcome of the NRC's proceeding. Nevertheless, a judicial settlement may be a necessary precondition for any managerial initiative at the site. If so, it would probably involve provisions for establishing limits to the liability of one or more of the parties to the settlement.

Could an agreement be reached outside the courts, whilst retaining a generally constructive and cooperative attitude to the problem? Perhaps so, but the ground would have to be carefully and publicly prepared, in order to avoid lengthy court challenges, for example by public interest groups to whom the agreement could assume the appearance of a comfortable accommodation among established bureaucracies.

Such thoughts are, of course, speculative. Nevertheless, they suggest an alternative solution: should it prove necessary, the Congress could authorize the federal ERDA, as the entity best suited to the task, to manage the West Valley waste. ERDA would then proceed to develop an expanded set of waste-management options. This assessment would be unhindered by any legal or political complexities concerning the question of agency responsibility. NRC would then formulate guidelines on the basis of the assessment, and the Congress would appropriate funds enabling ERDA to fulfill its role as waste manager in accordance with the guidelines set by NRC. These guidelines would probably require modification as the work proceeded. Meanwhile, efforts would be made to allocate the financial responsibility for the waste treatment and disposition among NFS and the federal and state governments. If that question ultimately requires judicial settlement, then so be it. But the question need not be resolved before beginning work at the site.

Guaranteeing the necessary funds even before the determination of financial responsibility would be an unusual step for Congress to take. Yet it is precisely here that the major advantage lies: by distinguishing between the delegation of managerial responsibility and the allocation of financial liability at the outset, the possibility of still more delay (caused, this time, by legal or political wrangling over who should bear the costs) can be avoided. In any event, the cost of further delay — mea-

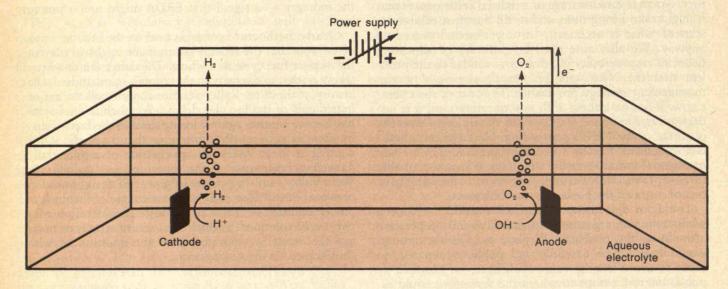
sured in terms of both a potential degradation in the integrity of the existing liquid waste confinement, and a heightening of public unease about the waste issue generally — must be carefully assessed if the current problems of West Valley are not to be compounded.

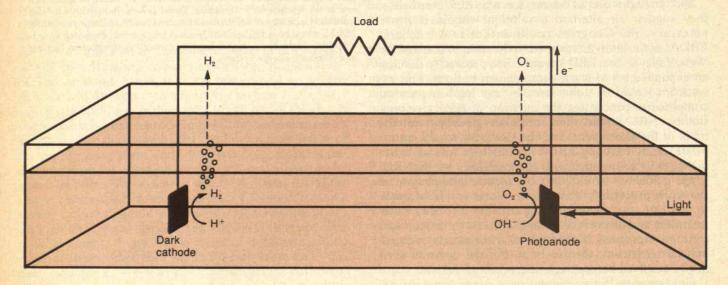
Both the federal ÉRDA and some elements in Congress are concerned that a federal assumption of responsibility for the waste at West Valley would constitute a precedent for federal "bail-out" of private firms incapable of meeting federally imposed regulatory requirements. On the other hand, ERDA is also concerned that a federal failure to assume responsibility at West Valley would discourage other private ventures into the fuel cycle. At a time when the nuclear industry is struggling for momentum amidst a welter of delays, criticism and uncertainties, such a decision could be interpreted as a signal of abandonment to the industry — a signal that ERDA might prefer not to send.

Clearly, both sets of concerns bear on the broader issue of the role that the federal government ought to play in the nuclear fuel cycle as a whole. The debate on this issue seems certain to intensify in the coming years. Indeed, the history of the West Valley venture contains all the major ingredients of the broader debate. So much is unavoidable, but we caution against losing sight of the fact — easily done in such an atmosphere — that a specific job is waiting at West Valley. In anticipation of a potentially damaging evacuation of the sphere of responsibility at West Valley, and in acknowledgment of the connection between West Valley and the future course of the nuclear power industry in the U.S., we urge consideration of a two-tiered solution, in which the issue of who is to manage the waste is separated from the question of who should pay for the management.

Richard K. Lester received his B.Sc. in chemical engineering from Imperial College, London, then came to M.I.T.'s Department of Nuclear Engineering as a Kennedy Scholar. He is currently a Visiting Research Fellow at the Rockefeller Foundation. David J. Rose received his B.A.Sc. from the University of British Columbia and his Ph.D., in physics, from M.I.T., where he is Professor of Nuclear Engineering. Professor Rose is a member of the National Academy of Sciences' Committee on Nuclear and Alternate Energy Systems.

Through the use of semiconductors immersed in liquid electrolytes, the energy of the sun can be changed to electricity or used to generate storable fuels.





#### Top:

An electrolytic cell for the chemical decomposition of water. Electrical energy must be supplied by the battery at the top of the illustration. Gaseous hydrogen appears at one electrode, gaseous oxygen at the other.

#### Bottom:

A photoelectrochemical cell for the chemical decomposition of water. Here it is light which instigates the electrolysis when it shines upon a semiconductor of the proper composition. As before, hydrogen and oxygen are liberated; but here electric current is produced, not consumed.

# **The Chemical Conversion** of Sunlight

Man's exploration of space has firmly established sunlight as a useful source of energy. After all, solid-state devices called photovoltaic cells, which efficiently convert solar energy to electricity, are now used to reliably power communication satellites, Skylab, and other manned space vehicles. But cost precludes the widespread terrestrial use of solar cells developed for space applications. Only in applications where conventional electric power transmission is not feasible — remote weather monitoring stations, ocean buoys, telephone communication repeater units, etc. - have we seen the use of solar-to-electric energy converters on the surface of our planet. However, these low-power, geographically remote applications do attest to the potential utility of electric power generation from sunlight.

Cost will remain important in the development of photovoltaic cells for large-scale practical use, but a second key factor concerns storage. The rising and setting sun in itself poses a problem; and beyond that, every period of cloudy weather rapidly brings to mind the need to somehow save the energy from the sun for use on a

rainy day.

There may, however, be a way to eliminate this second problem. Eons ago, our now depleted fossil fuels were formed as the ultimate result of photosynthesis, a natural solar energy photochemical conversion system operating in plants. Today, chemists are studying the possibility of also using sunlight in a direct way, to make storable fuels from abundant, cheap materials. The concept of depositing sunlight energy as stored chemical energy for retrieval when needed obviously neutralizes the problem associated with intermittent solar insolation. Potentially, chemical solar energy conversion systems could be just as efficient, reliable, and inexpensive as competitive photovoltaic systems.

The Chemist's Up-Hill Struggle

Photoconversion of a low-energy material to one that can be used as a fuel is not easy. Such transformations might be termed "the chemist's up-hill struggle." Consider the effort expended to roll a boulder up the side of a smooth hill. At any point in going up the hill, the boulder could easily roll back down, releasing the stored energy associated with having moved it upward. Chemists face a similar problem in trying to raise the energy of materials by putting in sunlight energy. In a situtation analogous to the boulder rolling downhill, there is often a tendency for the energy of a material to be prematurely released, precluding storage of the light energy.

The illustration on page 32, however, depicts a situation where there are resting points along the side of the hill. If the boulder is rolled up to one of the resting points, it still represents considerable stored energy, but the energy cannot be released unless the boulder is given a push over a small barrier that now intervenes between it and the downhill slope. Thus the stored energy need not be released until triggered by the activation energy to overcome the barrier. In chemical storage of solar energy, one likewise needs to build barriers that preclude the release of energy until it is needed. Conventional fuels have such barriers. Everyone knows that the release of heat from a mixture of natural gas (CH<sub>4</sub>) and air must be initiated by a spark or a lighted match.

The chemist's up-hill struggle in converting sunlight to storable chemical energy involves, in part, the clever introduction of barriers to preclude back reactions that may prematurely release the stored energy. Finding mechanisms (the detailed pathways in transforming one material to another) that provide optimum barriers is part

of the challenge.

Consider the light-induced dissociation of gaseous

$$CO_2$$
 light  $CO + O$ 

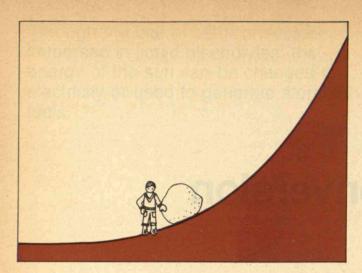
The reaction results in the high-energy products CO and O, which can recombine with essentially no barrier and immediately release a great deal of the light energy that served to break them apart:

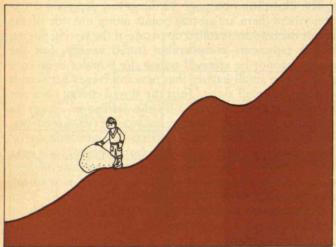
$$CO + O \longrightarrow CO_2 + heat$$

Alternatively, though, the oxygen atoms may couple to yield molecular O2:

$$CO + O \longrightarrow CO + \frac{1}{2}O_2$$

Now CO and O2 still represent a high-energy molecular arrangement, but the two do not revert to CO2 unless some activation energy is supplied — a spark, a match, etc. The situation is as sketched on page 33. In short, the CO, O<sub>2</sub> mixture is thermodynamically unstable with respect to conversion to CO<sub>2</sub>, but due to the barrier the mixture is kinetically inert. That is, the CO, O2 mixture can be stored indefinitely. Removal of the O2 would be advisable, however, since the CO and 1/2 O2 is an explosive mixture: a simple spark could trigger a release of energy at a devastatingly fast rate. Recovery of the stored energy could easily be accomplished by burning CO with O2 in the air to evolve heat and CO2:





The chemical creation of a fuel is likened to the effort to roll a boulder up a hill. In the first drawing, there are no resting places; the boulder can at any point roll back to the bottom. In the second drawing, a series of small hills acts as a set of barriers to the loss of energy.

$$CO + air$$
 burn heat  $+ CO_2$  in the same way as natural gas is used:

$$CH_4 + air$$
 burn heat  $+ CO_2 + 2H_2O$ 

The sunlight-induced conversion of CO2 to CO and O2 is, in fact, a fairly attractive reaction from several points of view: the energy storable per unit weight of CO is considerable; the product is a gas that is easily stored and transported; the fuel can be burned in air to release energy; and the starting CO2 is cheap and abundant. Unfortunately, CO2 is transparent to the sun's rays: prolonged exposure to sunlight does not in itself change CO2 into the desired CO and ½O2, nor, for that matter, does it change CO2 into anything else. Moreover, a better mechanism than that shown on page 33 must be found to insure good efficiency for the CO2 to CO + 1/2 O2 conversion. The difficulty is that the input light energy necessary to dissociate CO2 to CO and O is far greater than can be stored in the ultimate, kinetically inert products CO and 1/2 O2. Thus the barrier energy is simply wasted as heat, and the storage efficiency is lowered. Beyond that, the photogenerated CO and O may not even decay to the desired products. Rather, they may merely recombine to regenerate the starting material and waste the sunlight completely into heat. Chemists are seeking new mechanisms for sunlight-induced reactions which do not involve energy-wasting intermediates like O atoms and instead employ sunlight-absorbing materials called photoassistance agents, which serve to efficiently absorb the sunlight energy and channel it into desirable chemical storage reactions.

# Challenging Photosynthesis with Photoelectrochemical Cells

One chemical reaction that could serve to store solar energy is the sunlight-induced conversion of water to hydrogen and oxygen:

$$H_2O$$
 sunlight  $H_2 + \frac{1}{2}O_2$ 

H<sub>2</sub>O, of course, is abundant and cheap. As for the reaction products, H<sub>2</sub> represents exceptional energy storage per unit weight (about 14 times better than CO and 2 times better than CH<sub>4</sub>), and H<sub>2</sub> can be transported and stored easily. A promising mechanism for accomplishing this reaction involves the use of so-called photoelectrochemical cells, in which electrode systems play the role of the photoassistance agents.

Let us first consider a conventional electrolytic cell for the conversion of electrical to chemical energy. Such a cell is sketched on page 30. If electric current flows, then chemistry must occur at each of the electrodes. That is, at one electrode/electrolyte interface, electrons (e<sup>-</sup>) are transferred to some component of the electrolyte (the ionic solution filling the tank) and at the other electrode, electrons are transferred from some component of the electrolyte. Now removing electrons from a material corresponds to oxidizing it, and the electrode at which oxidation occurs is called an anode. Adding electrons to a material corresponds to reducing it, and the electrode at which reduction occurs is called a cathode.

Here is an example: simply viewed, water may be said to be in equilibrium with OH<sup>-</sup> and H<sup>+</sup> ions in solution:

These ions may participate in oxidation-reduction (redox) processes at electrodes according to the following reactions:

$$4H^+ + 4e^- \longrightarrow 2H_2$$
 (cathode process)  
 $4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$  (anode process)  
Overall:

$$2H_2O \longrightarrow 2H_2 + O_2$$

Thus, under appropriate conditions  $H_2$  gas can be evolved at a cathode and  $O_2$  gas at an anode. The net reaction is the electrolysis of  $H_2O$ . Such a process has been used industrially to produce  $H_2$ .

The  $\dot{H}_2$ ,  $\dot{O}_2$  mixture is thermodynamically unstable with respect to reversion to  $H_2O$ , but the mixture is kinetically inert, just like  $CO + O_2$ . Therefore, the electrolytic mechanism allows the conversion of electricity to storable chemical energy; and electrolysis has indeed been considered for load-leveling in nuclear power plants. Such plants operate most efficiently and conveniently at constant power output, but actual power demand can vary by as much as a factor of two or three over a twenty-four hour period. In times of low demand,  $H_2O$  could be elec-



#### Articles

How to Conduct an Effective Job Campaign A1 Frank Urbanowski on M.I.T. Press A3

### Departments

Under the Domes A5
A Fantasy on Room 10-250, Now Being
Renovated A6
New Experiments at the Bates LINAC A7
Problems in the Hole of the Metropolitan
Doughnut A8
Students A11
People A12
Alumni Involvement: How, What, Why
75 Pizzas a Night for 16 Years A13

#### Alumni Career Services: "Emotional and Informative Support"

"We're trying to teach people how to analyze themselves, as well as the job market — what to be sensitive to, how to explore leads. We're here to help alumni learn how to conduct an effective job campaign independently. We provide information, perspective and emotional support; we can't provide the magic. We put them in touch with an opportunity and they develop it. Success is up to them."

That's how Linda Stantial views her job directing alumni services in M.I.T.'s Career Planning and Placement Office. Between 500 and 600 alumni seek counsel each year, 30 per cent of them because they're out of a job, the rest because they seek work they think may be more rewarding. Their backgrounds and interests span the fields of science, engineering and business, from entry-level through upper management. Individuals gain exposure to the expertise of the placement service staff and benefit from some 1800 job listings received each year.

An alumnus registering with the office is asked to provide essential information: a resume along with a summary of career interests, geographic restrictions, and salary requirements. "I like the chance to talk with an alumnus if possible," says Ms. Stantial, a counselor by training. She considers this important for an exploration of an applicant's career concerns, job expectations, and goals. Her warmth creates a comfortable atmosphere for open-ended discussion. "You don't have to have all the answers before coming to see us," she emphasizes.

#### Try On Other Roles

The sort of questions she is asked: I feel there is limited growth potential for me in my current affiliation; what alternatives exist? How do I find a job in Denver? Is a radical career change feasible? Am I marketable with my cur-



Linda Stantial, who directs alumni services in the Career Planning and Placement Office: "We put alumni in touch with opportunity and they develop it. Success is up to them."

"A person is a cluster of different abilities that can be put together in a new package to fit a different job." rent skills at a higher salary level? How much opportunity is there for me in another field when I've been very specialized to date? I'd like to move into management; do I need an M.B.A.? How will personal priorities affect my career development?

One way an alumnus can gain perspective on these issues is to talk to someone who can act as an appropriate role model. "I'm interested in matching people with people, especially with other alumni where the ties are strong," says Ms. Stantial. "I generally find that alumni are pleased to share their perspective and observations with fellow alumni who are questioning their career direction. Ms. Stantial learns a great deal from older alumni and likes to transmit their experience to younger graduates to ease their transition into the work world.

An alumnus is welcome to come in and research alternative possibilities on a casual basis, says Ms. Stantial. He or she can try out lots of ideas, putting fantasies out on the table to see what sense they make. People can also compare. "I want to see if where I am is the best place." So they explore other possibilities for six months, only to discover that where they are is wonderful on a relative scale.

#### **Marketing Strategy**

Looking for a job is a highly individualized and personal process. Marketing oneself must be tailored to one's own style and to one's particular field of interest. "We spend many hours with alumni helping them develop strong resumes and outlining their search campaigns," Ms. Stantial explains.

It is important to prepare for interviews as well. Candidates must be ready to field diverse questions about themselves, as well as gather the impressions and information they need to decide whether the job they are interviewing for is one they really want. An open, relaxed attitude is ideal, if difficult, to achieve. "Too often applicants assume that the person on the other side of the desk has it all together professionally and personally. I try to help the nervous applicant relax by letting him see that the interviewer is probably just as nervous as himself and just as uncertain what to ask," says Ms. Stantial.

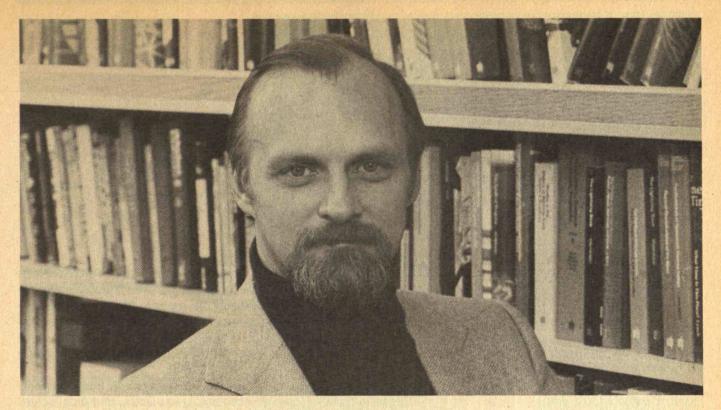
#### Freedom to Choose

Years ago, people chose a career and stuck with it (once an engineer, always an engineer). In many cases this meant working for one organization throughout one's work life. Now, people may make several seemingly radical career changes over a lifetime where the pivotal point is the person — who is multifaceted," says Ms. Stantial.

She helps people discover talents they're not aware of. A person is a cluster of different abilities that can be put together in a new package to fit a different job, she says. Skills are too often identified with academic credentials, she adds, so that many valuable assets, like organizing people or writing well, are often overlooked as marketable talents.

Ms. Stantial likes to look beyond the job search, to talk about the ramifications of a career choice, about problems of a two-career family, about work as a part of living which should be enjoyable in itself.

"Alumni sometimes think they are only faces to us," she says. "But we do invest emotionally — we want to know how they're doing. They are the focus of our day; our feelings of satisfaction stem from our sense of helping them with their lives." — M.L.



#### Frank Urbanowski on the M.I.T. Press

University presses were established to reflect the special interests and strengths of the institutions they represent. Their unique contribution was to sense and try to exploit academic areas of nascent significance. That's a risky business, for which commercial houses are ill-suited by talent and constitution. But because university presses could rely on income from subsidy and endowment, they didn't have to worry about self support.

That luxury is no longer available to any major university publishing house, and now the goals and problems of a university press are very different. "Today, our publications are as much a reflection of our sensitivity to what's happening in the marketplace as they are of our scholastic interests," says Frank Urbanowski, M.I.T. Press Director. "We must try to anticipate audience interests. We no longer exist to publish material that commercial presses don't want."

M.I.T. Press is by far the youngest of the major university presses, and as a consequence it has always had to be more budget-minded than its wealthier sisters. Although an editorial office was established 50 years ago at M.I.T. to prepare manuscripts for publication (under the name of Technology Press) by John Wiley and Sons, the independent M.I.T. Press qualified to edit, publish, distribute, and promote-its books wasn't established until 1962. Probably for that reason, the Press has not had access to the endowment funds enjoyed by other large university publishing houses, most of which were established at the turn of the century.

The Press is unique in other ways, as well — in its approach to design, for instance. "Somewhere along the line, we decided to adopt a different design perspective than that of the conventional scholarly publication," says Mr. Urbanowski. "We use paper and type styles to create an innovative design that gives each book an appropriate visual identity. Our success is proven by the number of design awards we hold from the American Association of University Presses, as well as other awarding groups."

The books themselves are as distinctive as their design. The Press prefers to develop its list of titles in a series, and to establish its reputation

Frank Urbanowski, Director of the M.I.T.
Press: "Our publications are as much a reflection of our sensitivity to what's happening in the marketplace as they are of our scholastic interests."

"We must try to anticipate audience interests. We no longer exist to publish material that commercial presses don't want." Since its independence, the Press moved its emphasis from engineering and science to political science, economics, linguistics, and architecture and urban planning. "A factor in that shift was the growing competition from commercial publishers in hard science disciplines . . . Now we are turning back toward science and engineering . . ."

within a discipline. Mr. Urbanowski says that 65 per cent of M.I.T. Press books fall within such focused publishing programs. "The linguistics and architecture programs are well established," he reports, "thus they are successful and command substantial markets." Other programs — in neuroscience, transportation systems, computer science, artificial intelligence, economics, public policy, health science, and technology — are now being defined.

Since its independence, the Press moved its emphasis from engineering and science to political science, economics, linguistics, and architecture and urban planning, says Mr. Urbanowski. "A factor in that shift was the growing competition from commercial publishers in hard science disciplines. We began to encounter other publishing representatives on campus looking for science and technology material — and it wasn't easy to publish our own faculty even when they did have the time to write. So we moved in another direction. But now we are turning back toward science and engineering; that's because the markets are growing, especially abroad. Now 25 per cent of our trade is foreign; I would like that to reach 30 per cent or higher."

The M.I.T. Press list comprises some best-sellers that bring a profit, some break-even books, and some subsidized programs. An example of the latter: the Mellon Foundation provided a subsidy to publish new, young authors in the humanities and social sciences. ("We were honored, especially since we're not primarily a social sciences and humanities publisher," says Mr. Urbanowski.)

The most speculative of publishing ventures are trade books. College textbooks are more economically secure. "There you know precisely what the market is, and what competition will be faced.

"Books that can be revised, such as textbooks and reference books, will form a greater part of the underlying structure of the Press. We can count on revising them every four or five years.

"The best money we spend is on reprinting, when a book is out of stock and still selling. For any publishing company, the backlist is the bread and butter of sales. One-third of the \$1 million a year we spend on composition and printing is on reprints. I would like to see a larger portion of our production budget devoted to reprints."

How much to charge for a book? That depends on both production costs and the M.I.T. Press' estimate of what the market will bear. "It's easy to get stuck in costs, so we focus on the market," says Mr. Urbanowski. The rough formula: the book should be priced at five to six times its unit cost. A typical budget for a new book: 24 per cent printing and binding, 10 per cent royalty, 15 per cent fulfillment, 16 per cent marketing, 10 per cent editorial, 15 per cent general costs (building, employees, debts). "The first printing should be as small as possible to avoid a large inventory. Cash in the bank, not books in the warehouse earns interest. But keeping print runs in line with inventory levels is a perennial problem of publishing." — M.L.

#### **Under the Domes**

#### Needed: Louder Voices for Aeronautics and Astronautics

Aerospace is "the last unlimited frontier," but its protagonists and practitioners are a tiny (one-half of one per cent) — and largely uncommunicative — segment of the population. Indeed, the gulf of ignorance between these professionals and the rest of society, "most of whom reason by gut feeling rather than systems analysis, to whom feeling is believing, who rarely stop to question why," is "one of the most serious problems facing the aerospace community," says Professor Rene H. Miller in an Astronautics and Aeronautics editorial.

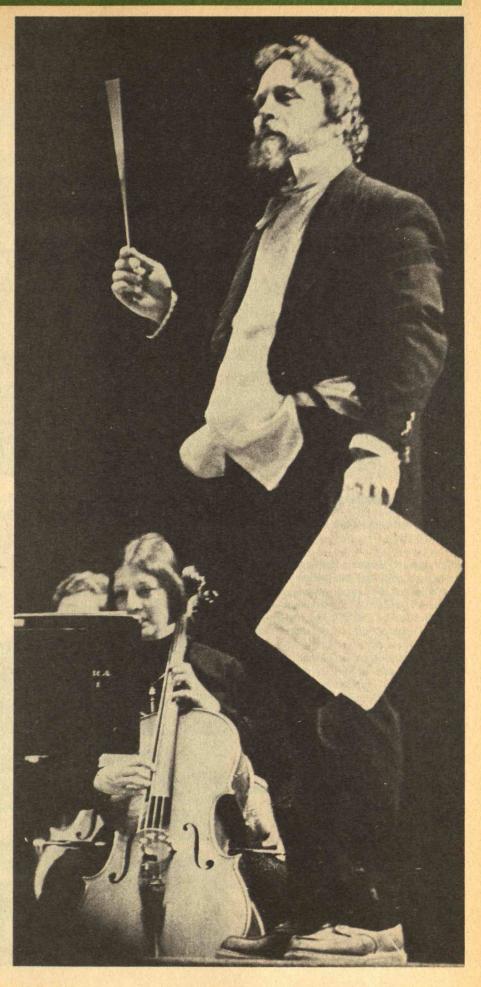
"We have failed to explain the space program — what it does and what it can do to improve the quality of life for all," says Professor Miller, who is serving as President of the American Institute of Aeronautics and Astronautics this year.

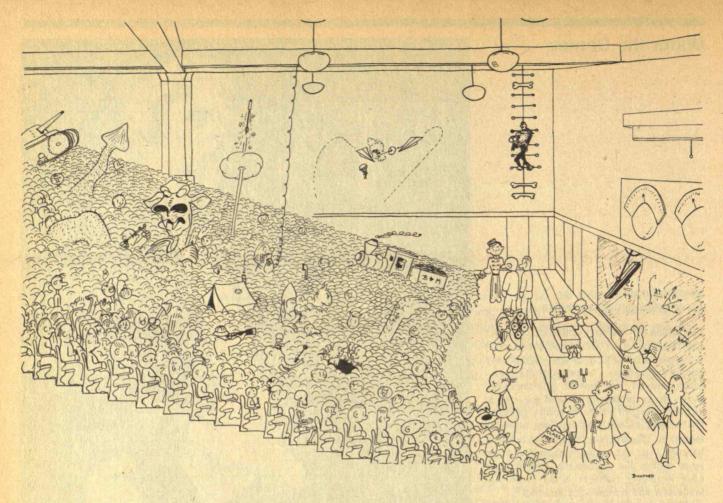
"We have failed to explain the wonders of our air transportation system, which offers trans-Atlantic travel for half the price of 20 years ago when most other prices have doubled.

"We are not communicating with the 99½ per cent of the nation who provide the funds and make the policy which controls their disbursement.

"We technologists do not make nor do we greatly influence policy," Professor Miller wrote. "We could, and I believe we must," he told A.I.A.A. members.

"A perfect admixture of farce, satire, and music" is how William Lasser, '78, described the evening late in the winter when Professor Peter Schickele came to perform as soloist with the M.I.T. Symphony Orchestra - and ended up conducting as well because nobody else was available to do the job. The program included P.D.Q. Bach's famous "Hindenburg Concerto" (Schickele conducting) and "Concerto for Bassoon vs. Orchestra" (Schickele soloist). Mr. Lasser complained that "the orchestra seemed at times ragged" in the "Hindenburg" — "some of the balloons were released at inopportune moments." (photo: John Grunsfeld, '80, from The Tech)





### From the Sublime to the Ridiculous in Room 10-250

When John H. Bickford, '50, was a sophomore, he contributed this fantasy on Room 10-250 to Voo Doo, and it's now carefully framed and preserved in Historical Collections. But to Mr. Bickford and his generation, the photograph (right) would have seemed almost as fantastic: the fate, in the hands of wrecking crews, of more than 500 60-year-old seats in M.I.T.'s most famous lecture hall now undergoing renovation. A completely remodelled, air conditioned hall will be ready for use next fall. Meanwhile, the "tablet" arms from the old chairs are safely in storage, ready to go to Alumni Fund donors of new chairs to replace the old. (Photo: Calvin Campbell)





#### New Experiments at the Bates LINAC

New facilities — in all, about 30,000 square feet of new experimental space — will be added at the Bates Linear Accelerator in Middleton, Mass., by August, 1979. The cost will be close to \$5 million, and the work will begin this fall with support from the Energy Research and Development Administration.

There will be no changes to the linear accelerator itself. But the new space will permit the Bates LINAC to be used for new experiments which can't be done now. "We want to invite people to be imaginative over a broader range of physics," says Peter T. Demos, Ph.D. '51, Professor of Physics who is Director of the Bates LINAC.

The main feature of the new addition will be a second experimental hall of 15,000 square feet in which high-energy experiments can be located. Shop and assembly space for these new experiments is to be added, and there will be offices and a data acquisition building. The project also includes an experimental yard — an outdoor paved area where the electron beam from the LINAC can be directed to mobile research equipment.

The Bates LINAC consists of a 600-foot underground tunnel containing the evacuated tube through which the electron beam is accelerated. E.R.D.A. classifies it as a

tool for medium-energy physics — a field which involves the study of nuclear structure with particles energized to between 150 and 6,000 million electron volts.

#### **Grover Hermann Professorship**

The Grover Hermann Professorship in Health Sciences and Technology has been created by a \$1 million gift of the Grover Hermann Foundation of Chicago; the chair will go to a "distinguished and creative scholar" engaged primarily in teaching in the Harvard-M.I.T. Program in Health Sciences and Technology.

Mr. Hermann is the retired Chairman of the Martin Marietta Corp., formed in the merger of American Marietta Co. (of which Mr. Hermann was founder and President) and the Martin Co. of Baltimore, Md. Mr. Hermann was a major contributor to M.I.T. in the Second Century Campaign in 1961, and his gift in 1963 made possible construction of the Grover Hermann Building which houses the Dewey Library and parts of the Departments of Economics and Political Science.

The Hermann Professorship brings to 17 the number of chairs thus far endowed or pledged through the Leadership Campaign; 50 endowed professorships are included in that Campaign's \$225 million goal.

When? Who? Where? Impeccable logic stands behind the answers: It's St. Valentine's Day. The Logarythms — M.I.T.'s undergraduate "barber-shop" singers —are serenading Gail Macdonald. And the scene is the Student Financial Aid Office, where Ms. Macdonald is Administrative Assistant. (Photo: Calvin Campbell)



Governor Michael Dukakis to members of the M.I.T. Corporation: "a growing, prosperous future relationship" between M.I.T. and Massachusetts.

#### The Governor Pledges a Partnership

Having resolved his most pressing emergencies after two years in the State House on Beacon Hill, Governor Michael Dukakis is ready to develop and capitalize on a new partnership between the political and intellectual leadership of Massachusetts.

"It is incomprehensible," he told members of the M.I.T. Corporation and their guests at the luncheon following the Corporation's third meeting of the academic year early this spring, that the state has so little used this "enormous resource" represented in the faculties of its colleges and universities

Now that he has begun to reach out to them, the Governor said, "You have been so very forthcoming on a lot of very hard jobs" — environmental issues, transportation, energy, food, and the management of coastal resources. The luncheon was to celebrate M.I.T.'s official designation as a Sea Grant College — an important event for the state, said the Governor — the basis, he hopes, for a "growing, prosperous future relationship" between M.I.T. and the Commonwealth.

The Governor of Massachusetts is ex officio a member of the M.I.T. Corporation, and this was Mr. Dukakis' first public participation.

#### Problems in the Hole of the Metropolitan Doughnut

It's true that some of America's largest and oldest cities are perilously close to financial default. But it's not true that the bankruptcy of New York, or Boston, or San Francisco would bring financial disaster to America.

Quite the contrary, says John F. Collins, former Mayor of Boston who is now Consulting Professor of Urban Affairs in the Sloan School of Management. True, default by a large city would trigger nervousness and even hysteria in the financial community — for a few weeks. But it would open our eyes, as nothing else, to the facts of life —that big cities are big business, and that financial mismanagement has the same effect on a city that it has on a business.

There's no other way, Professor Collins told the annual dinner of the M.I.T. wives' organization late last winter: you can't shrug your responsibilities — welfare, for instance — off on the federal government; you can't rely on an image of action to take the place of real performance; you can't go on forever with mayors who find it impossible to say "no"; you can't manage a city with a combination of civil service and collective bargaining; you can't go on forever with central cities being turned into "the hole of the metropolitan doughnut."

#### Our (High) Share of the N.S.F. Fellows

Twenty-two present and former M.I.T. students are among 550 winners of graduate fellowships from the National Science Foundation for 1977-78; that's an even 4

per cent. Eight of these will bring their fellowships to the Institute.

In addition, 38 other N.S.F. fellowship winners for 1977-78 have designated M.I.T. as their graduate school. In all, therefore, 46 students chosen by the National Science Foundation for outstanding ability in the sciences, mathematics, and engineering will be at M.I.T. next year; that's over 8 per cent of the total of 550 N.S.F. fellows.

#### Managing Ignorance On the High Seas

The arguments which have drawn the Law of the Sea Conference into its sixth weary session arise as much from ignorance as from greed. We know so little about the seas and their resources that no nation knows how to value its options: what seems unimportant in today's ignorance may later be revealed as crucially important.

And ignorance turns out to be a selffulfilling prophecy.

Consider, for example, the Indian monsoon, upon which depends the food supply of at least 550 million people. The amount of rain it brings to India depends on the temperature of the Indian Ocean, and that in turn is controlled by a coastal current off Somalia. What will happen to the monsoon if this current is somewhat changed, even slightly? No one knows; and no one can try to find out, because Somalia has closed its coastal waters to oceanographic research.

Another example: on the world anchovy supply hinges the world soybean crop, and the anchovy supply in turn is related to temperatures and currents in the world oceans; and no one really knows how those currents and temperatures are controlled.

"It is hard to convince an outsider of how little we know about the oceans," says Carl I. Wunsch, Professor of Physical Oceanography at M.I.T.

Knowledge — as well as lack of knowledge — affects policy. The fact that we know how to bring up nodules from the bottom of the Pacific — even though we've not used them — has served to stabilize world prices of cobalt and nickel, says Professor Ira Dyer, Head of M.I.T.'s Department of Ocean Engineering.

Robert M. White, Administrator of the National Oceanic and Atmospheric Administration who shared an M.I.T. platform with Professor Wunsch late last winter, sees "remarkable new interest ... worldwide recognition of the importance of the oceans." The problem - for the U.S. and other nations, too - is to devise management authorities and systems which recognize the unique, interrelated qualities of ocean systems. Today we manage the oceans as if they were extensions of the land — their food resources under the Department of Agriculture, their energy resources under E.R.D.A., their mapping under the Department of Commerce. A unified, specialized management would be better, Dr. White says. - J.M.

03

I note the passing of another venerable classmate, **Benjamin D. Solomon**. Ben led a quiet business life until recent years. He was a deep student and found the time to study law at Northeastern University nights to acquire his degree as an aid to his administrative work.

Many of you recall the annual "Cane Rush," to test the athletic prowess of the student body. Here Ben Solomon secured the high honors in the terrific struggle. Ben was a powerful athlete — an expert rope climber in gym — which aided him in establishing a place in our 1903 history for the year.

He is survived by a loving wife and a very devoted son-in-law, Dr. Alfred Hurwitz of 10 Abernaki Rd., Augusta, Maine.

Happy birthdays were celebrated by **John J. A. Nolan**, April 3, 1881; and **Clarence M. Joyce**, April
1, 1881. — **John J. A. Nolan**, Secretary, 13 Linden
Ave.. Somerville. Mass. 02143

05

Roy H. Allen writes, "I have been retired for the most part since 1949; for the past 13 years I've lived in the very nice Orangewood Estates sponsored by the American Baptists here in Phoenix, Ariz."

C. Dean Klahr of Erie, Penn., died September 26, 1976. After graduating from the University of Pennsylvania in 1901, he received a degree in mechanical engineering from M.I.T. in 1905. Prior to his retirement in 1945, he had been a partner in A.J. Fasenmyer Co., a construction engineering firm. He had been involved in the Junior Sailing Program of the Erie Yacht Club, was active in United Fund campaigns; and was a charter member of the Church of the Covenant, where he had served as an Elder and Trustee. — S.F.

07

John C. Bradley received a letter from Mrs. Frank S. MacGregor of Tryon, N.C., informing of her husband's death on December 31, 1976. Mr. MacGregor had been active in class activities and a faithful correspondent in the Review. He graduated from M.I.T. in physics and was a general manager with du Pont Razor Co. in New York in the 1930s and in 1945 was general manager of the electrochemicals department of du Pont in Delaware. I have no other details of his career. — S.F.

08

We are sorry to report the deaths of two classmates. Arthur B. Appleton, of Beverly, Mass., dled February 18, 1977. He graduated in civil engineering and was an engineer in the Massachusets Department of Public Works for 36 years. He leaves his wife Marietta C., a son, and a sister. ... Hobert W. French, of Concord, Mass., died December 14, 1976. Mr. French was a manufacturer's consultant in Erie, Penn., until his retirement in 1966 when he relocated to Concord. He served in France in World War I, and was a member of the Irving Legion in Boston. He was also a member of the Thoreau Foundation Inc. He leaves a son, Hobert W., Jr. of Concord. — Joseph W. Wattles III, Secretary, 600 Washington St., Wellesley, Mass. 02181

10

Glenna and Carl Lovejoy of Boynton Beach, Fla., are a "well traveled" couple. One of their recent trips was to Orlando, Fla., where they attended an M.I.T. affair. There they had the opportunity of hearing President Wiesner address a group of about 200 persons interested in the recent activities at the Institute. Carl advised me that such trips are easy (for him) since Glenna does the driving. In addition to special trips around the country, they usually spend several months each year at Black Mountain in the western part of North Carolina, not far from Asheville. In fact, they call this their "second" home.

As I compile these notes (in mid-March) for the May issue of the *Technology Review*, I look out at the vanishing snow and hope that it really signals the end of a winter which has been one of the toughest ones we have ever had in Maine. — John B. Babcock, Secretary, 33 Richardson St.,

Portland, Maine 04103

11

Allston T. Cushing is retired and living with his wife at 517 B Peace Parkway, Lee's Summit, Mo. He notes the sparcity of 1911 class news and wonders, "Am I eligible to form a 'Last Man's Club' for this class?" Please send in your news to the *Review* and keep him company.

Colonel **D.P. Gaillard** writes that he is nearly 87 years old. He is still in "fair health and now has one great-grandson." . . **Willis K. Hodgmen, Jr.**, Course II, writes, "Retired, not active."

Rock Comstock, Sr., '12, informs of the death of Norman Duffett, his roommate throughout his years at M.I.T. He wrote, "As Mrs. Duffett (Edith) tells me, he fell and broke his hip on November 23, and died eight days later. Norm and I met at the Deke House - we having been of that persuasion, he for two years at Rochester and I for one year at Colgate. However, for differing reasons, we did not affiliate but decided to room together -- since we were both from western New York and with similar backgrounds. Norm was a highly moral man, both physically and mentally, never smoked or drank - nor did I - was very articulate and of an independent turn of mind, dedicated to his work - and eventually became General Manager of the Union Carbide Plants at Niagara Falls.

O. Wellington Stewart of Kingston, Mass., died

December 27, 1976. He was treasurer and manager of the inspection department of the Factory Mutual Fire Insurance Co. at his retirement in 1950. After his retirement, he began growing cultivated blueberries and gained a national reputation for his work in introducing new varieties. He was chairman of the research committee of the Southeastern Massachusetts Cultivated Blueberry Assn., and experimented with methods of keeping the berries free from the ravaging of birds. Mr. Stewart was also chairman of the Kingston Fish Committee and supervised clearing of herring brooks; a member of the Appalachian Mountain Club and the Jones River Historical Society.

Chester Pepper of Melrose, Mass., died February 6, 1977. He was retired civilian head of the safety department of the old Watertown Arsenal, and was responsible for the plant's winning several safety commendations. He had also been employed at one time by the Factory Mutual Insurance Co. and Burdett College. Mr. Pepper had served on the Massachusetts Board of Education and was a life member of the American Society of Safety Engineers. — S.F.

12

It is with deep sorrow and regret that I compile these notes. Too many of our friends and associates are dropping out. I guess this is te be expected when most of us are in the 85-95 age bracket. Those of us who are still going on appreciate, I am sure, the extension of years granted to us. We have had a good life and are thankful for our many blessings.

Chester Dows passed away in his sleep while on a visit at his daughter's home in Garden City, Long Island, December 28, 1976. He had been ill and feeble for a number of months. Chester retired in 1952 as head of the Tests and Standard Section of the Application Engineering Department, Lamp Division of General Electric. He joined this Section in 1912. He served as treasurer of the First Baptist Church in his home town of Cleveland Heights, was a member of the A.I.E.E. and the Illuminating Engineering Society, and was a Mason for many years. He wrote many technical articles on lamp testing and standards. Surviving are his wife Frances; a daughter, Dorothy Kopf, and a son, Richard; a brother and sister.

Franklin N. Breed died at his home in Wilton, Conn., in December, 1976. During World War I he went to France as a member of Tech Unit, American Field Service, and later served in France in the Army Corps of Engineers. He went into private practice in Wilton, Conn., in 1922. He designed many homes and churches in Fairfield County and was a member of the American Institute of Architects, the New York Architectural League, the Block Island Community Church and the Wilton Historical Society. Survivors include his wife, Marjorie; two daughters; two step-children; two grandchildren and two great-grandchildren.

Oliver W. Holmes died peacefully in his sleep at

the home of his daughter Mrs. Charles Borton at Windmoore, Penn., January 14, 1977. Oliver was employed by G.E. in Schenectady and was in business for himself in Eastport for several years. He was an employee of the Holmes Packing Co. for 25 years. Survivors include a sister, Mildred Holmes of Eastport; two sons and two daughters; nine grandchildren and four great-grandchildren.

John L. Barry III died January 11, 1977 at the South Shore Hospital after a brief illness. John was the retired treasurer and general manager of Cynthia Mills, an East Boston textile firm. He held several patents on machinery for winding woolen yarn. He was a member of Hingham Yacht Club, the Union Club and the Harvard Music Assn. Survivors are his wife Ruth; four daughters; 12 grandchildren and two great-grandchildren.

Johny Noyes reports on what he terms a "Hilarious Cruise" on the Caribbean. He was chosen "King-of-the-Ship." John gives no details — I think he is holding out on us.

Harold Brackett writes (February 14) they are right in the midst of a natural gas shortage and are keeping the temperature down to 65°. It is so cold, they look forward to going to bed. They have shut off the heat in all the bedrooms and are using only a small one-burner-top-of-the-stove oven for baking. Harold and his niece, Eleanor Forbes, have reservations at Sun 'N Sea Apts. on Longboat Key, Fla., from April 3 to 17. We hope that you will have good fishing Harold, and will have a good chance to get warm.

Had a nice letter from **Wallace Murray** (January 30). He says the winter has been very cold, often down to zero, and lots of snow. He is living alone in Gorham, Maine, and says that so far they have had plenty of oil and that he is perfectly comfortable. He reports that a lot of his time is taken up with uninteresting house work but that he is fortunate to be living right across the street from the library and near the center of town so that stores, banks and churches are quite handy. He says his health is fair but that he has to see his doctor often and takes lots of pills. He hopes to get to the Reunion but is not sure he will make it.

Jim Cook says his general health is good. Having had several accidents, he refuses to take any chances with the snow and ice and has remained indoors all winter. Jim's hearing makes it most difficult to converse with others and on this account he does not plan to attend the Reunion. He sends hearty greetings to all who do attend. Jim, we are sorry that you will not be with us, we shall miss you and your pleasant smile and your little jokes. — Larry Cummings, Secretary, R.R. 4, Connersville, Ind. 47331

### 13

The literature regarding "Technology Day" has been received, but due to medical advice the Capens will not be there. Nothing serious — just "old age" coming on us.

We are asking **Heinie Glidden** to appoint a chairman for the 65th Class Reunion for June, 1978, and we will furnish him or her with any information desired. But we do not favor a Reunion; in 1975, the Class of 1910 celebrated on campus with only four or five members present.

It was a great shock to us to learn of the death of one of our closest friends, **Leon Parsons**. We received a short note from Dick Feingold together with a newspaper write-up from the *Hartford Courant*, dated March 8, 1977, from which these are highlights:

"L. W. Parsons, 85, of Windsor, a former Washington, D.C., representative for Tidewater Oil Co. (now Getty Oil Co.), died Sunday at New Britain General Hospital. Born in Newburyport, Mass., he had lived in Suffield almost 20 years before recently moving to Windsor. After graduating from M.I.T. and Harvard University (1916), Mr. Parsons was a captain in the Army's Chemical Warfare unit during World War I. Parsons joined Tidewater Oil in 1923 in New York as Chief Chemist. In 1941, he went to Washington as the company's representative, serving there until he retired in 1958. From 1941 to 1945, he directed international sales for Tidewater.

"Before joining Tidewater, he had been Assistant Director of the Laboratory of Applied Chemistry at M.I.T. and an Instructor in chemistry at Northeastern University in Boston.

"Parsons had done technical consulting for the Zeppelin works in Germany and, in 1937, was an eyewitness to the 'Hindenberg' crash in Lakehurst, N.J., that took the lives of 36 persons. After retiring, he was director of development for Suffield Academy in Suffield.

"He was a member of the Hartford Club and the Suffield Country Club and was a past member of the New York Athletic Club and the Cosmos, Congressional and Kenwood Country Clubs in Washington, D.C. He leaves a daughter, Mrs. T. Mitchell Ford, two grandchildren, and two greatgrandchildren." Mrs. Ford's address is 45 Windsor Road, New Britain, Conn., 06052.

Highlights of a letter from our Class President, Henry Glidden: "I don't know what has customarily been done in regard to class dues bills, but it seems to me it would be a good idea to set a moderate yearly amount, get the members to vote on this, and then collect it from everyone — all proceeds to be put in a bank account from which payments could be paid by check, making it easier for you, and more business-like. If a little fund accumulates, it can be used for any special project the Class many initiate, and be available so the Class would feel they have something in the treasury. Let me know what your feelings are in regard to this. I think it is recognized that a class should do something of this sort."

Also a letter from **Charlotte Sage**, Vice President: "About the bills and money: we all think you had better hang on to the money at present—never mind about this special alumni collecting for whatever building it is. Frank says we are due for a reunion in 1978 and will need the money then, and he thinks it would be a good idea to continue sending bills—dues are small, but they add up and will be in the fund when needed. Until the Class is dissolved by Father Time or we decide to dissolve ourselves, it is good to have the money available. Don't give up—you do a great job and we need you.

"Heinie says he wants to get out of everything, including being President, but he doesn't know to whom to resign to — certainly not to me. I was only an appointed V.P. and do not want to be anything more."

It is interesting to note in the February issue of the *Review* that William S. Brewster, '43, was one of 125 M.I.T. graduates awarded a citation as leaders in industry as presidents, vice presidents, chairmen of various corporations, etc. William Brewster is the oldest son of Ellen and **Ellis Brewster**.

To all of you loyal 1913ers, we hope that you will contribute to the M.I.T. Alumni Project of redecoration and expansion of the Main Lobby, — also to increasing your 1977 contribution of the M.I.T. Alumni Fund. And send us news of your activities. — George Philip Capen, Secretary and Treasurer; Rosalind R. Capen, Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

### 14

Alfred P. Kitchen died on November 5, 1976. Because the class records show only that he had lived in New Rochelle, N.Y., for the past five years, and before that in Havertown, Penn., I am seeking information on his career from the member of his family who reported his death to the Alumni Association.

Information reached me in March of the death of **Charles E. Woodlock** on October 11, 1971, at the age of 84. He was with us in only our freshman year. For many years, beginning in about 1920, he was an instructor in drawing in a high school in Waterbury, Conn. He was survived by his wife, the former Mabel Jerome Ryan, who died in March, 1977.

Ray Dinsmore, our President Emeritus, has a new address: 80 N. Portage Path, Apt. 6A12, Akron, Ohio 44303 — Charles H. Chatfield, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

### 15

Plan to be at our 62nd Reunion on Alumni Day, June 10 at the M.I.T. Faculty Club, 50 Memorial Dr., Cambridge. Plenty of free parking in rear of building. Cocktails at 4 p.m. are FREE, followed by dinner at the Club (no transportation needed) at \$7.75. Everyone is urged to come. — we may not be able to have many more!

What price a winter in Florida with the kind of weather there this winter. About March 1, Wayne Bradley returned from a month in the cold down there with a three-day suntan — the only good days he had. Incidentally, his Griswold Rubber Co. is in Moosup, Conn., and not Groton and his summer inn is Moosalaukee Inn, Warren, N.H. — a good place to go. I haven't seen our other "snow birds" since their return north.

Molly Swift phoned me from Elkins, N.H., that she had been in touch with Elmer Matthews, '17, an old friend of Speed's.

Phil Alger is at the Kingsway Arms Nursing Home is Schenectady. He had cracked his hip, but is walking well with a cane. . . Max Woythaler, our former Class Agent and a Class Director for a long time, is in St. Patrick's Manor Nursing Home in Framingham, Mass. . . . Alton Cook "the old Woof" planned to spend part of February and March with some of his family in San Jose and San Diego and hoped to make the trip through the Panama Canal. I hope he made it because it is a spectacular and impressive sight. . . Bill Holway says that at 83 years of age he is still active in his engineering work. Good for Bill!

From St. Petersburg, Fla., Sol Schneider wrote that his daughter, Janet, and he would be at our 62nd Reunion in June. . . . The Houston (Texas) Sunday Chronicle of January 30 carried a long story about John Stabu and his outstanding work. A piece from it: "Staub's career has produced a giant's share of Houston's elegant mansions and exclusive clubs. His clientele have been The Beautiful People."

What an experience Mary Rice must have had on her Russian trip. On her return home around February 1, she wrote me: "The trip to four Iron Curtain Countries was what I expected - traveling alone must have made the Russians suspicious of me. One must wait until reaching their airports before knowing which hotel one is staying. Thier very unsubtle method is to keep you at the airport hours - then take you to a hotel, late at night, miles out of the center of the city. The next day they keep you all day in the hotel, saying a room in the city is being sought for you - and too late to do any sightseeing. They have been booked by 'groups.' Trying to get around Moscow by their magnificent subway, at 83, was a disaster. Escalators are nearly perpendicular, racing at 40 m.p.h. - I fell head-first, two men grabbed me up on my feet - but I lost my desire to try their metro again. And too, it rained all the time, my \$43.50-aday room was never above 62 degrees - and I was glad to move on to Leningrad. There another hotel way out of the city - the 'Hermitage' was worth all the frustrations, and very poor food. Poland, Hungary, and Czeckoslavakia were less difficult and easier for me to get around alone. I hope to attend the one-day reunion in June and shall answer any questions you may have. I've just spent 24 days in Puerto Rico with a son, Pat, a broker with Merrill, Lynch, etc. Heavenly 84 degrees daily - delightful people, friendly and warm. So good to be with my nearly 7-yearold granddaughter, god-child and namesake, Angelica Mari, who I predict will be in the M.I.T. class of 1998.

What a tough break for **Bob Welles** who, with his two daughters, had such an unusual and unfortunate experience while East last summer. I hope they've completely recovered by now. He writes, "Last summer I was hoping to look in on you and see how you were doing. We got to the big show of ships in New York Harbor. In fact the ferryboat that we were on acted as the reception committee and exchanged three blasts with every ship as it came under the big bridge at the entrance to the harbor. I never saw so many boats and ships all at once before. From New York we

progressed to Connecticut and Massachusetts, and there I started having trouble. I went swimming in an infected pool and it gave me an intestinal ailment that kept me on the run and soon had me completely dehydrated. I tried a local doctor and a nice little hospital in Massachusetts but without any success; so my daughter and I flew back home and I went to the hospital where they immediately put me on intravenous feeding and pulled me out of trouble. For the Christmas vacation we flew to Tahiti where we (self and two girls) saw some lovely islands and had some nice swims and boat rides, but came down, all three of us, with a similar ailment (different bug but similar results) and again we flew back here and I went to the hospital. This time the dehydration caused me to come down with phlebitis and as I write this I still have to keep one leg up on a hot pad. I begin to wonder whether at 86 years it isn't time to begin to think about staying put." Bob is worried about the California drought; he's "still in the water business and beginning to worry about future supplies."

Here's an interesting letter from George Easter who survived the terrible winter. I like his crack about Buffalo. "In view of your plea in the last Review I had better drop you a line. For reasons unknown, my health stays marvelously good. Guess I must drink the right kind of liquor even though it is not Old Mr. Boston most of the time. I just passed my eye exam yesterday to get a license to drive without glasses for another four years. I usually read with them but can read a newspaper without them guite readily. My M.D. says my blood pressure stays fine. Well, Buffalo lived up to its reputation this year for the first time. The official word was that we had 181 inches of snow — which means 15 feet — and then it snowed some more after that. I measured the pile by my garage as nine-feet deep. I came back to all this after spending Christmas in Florida with my daughter in Tallahassee. But you don't shuffle off to Buffalo. You try to shovel out from Buffalo.

"My outside jobs this year are boiling three to four bushels of potatoes each Thursday for making salad for Fish Dinners at the church. I only boil 'em — then the women take over to peel and fix them. We serve about 600 a night during Lent so it is quite an operation. I also drive about once a week for Meals-on-Wheels, about 10 to 15 miles. I am only a substitute so get a different route most times depending on who does not show."

It's sad to report these deaths: Frank Murphy in St. Augustine, Fla., on March 20, 1976.... Charlie Calder in West Barnet, Vt., on December 23, 1976.... Joe Livermore in Oregon City, Ore., on February 12, 1977. Joe and his wife had left Ridgewood, N.J., to be with their son, Dick, in Oregon. Joe had been active up to the time of his last brief illness. Joe was a professional construction engineer and was active with Lockwood Greene up until his retirement at 80 years of age. These were all fine classmates and we shall miss them. The sincere sympathy of our Class goes to their families.

See you at our 62nd, June 10. — Azel Mack, Secretary, Apt. 26A, 100 Memorial Dr., Cambridge, Mass. 02139

### 16

May we remind you that we are gathering on June 7, 8, and 9 at the Chatham Bars Inn for our 61st Reunion. We sincerely hope that all who want to attend will be able to come. If you can't come and want to share it with us anyway, send along a card to Ralph A. Fletcher, M.I.T. Class of 1916, c/o Chatham Bars Inn, Chatham (Cape Cod), Mass. 02633. Mail it to arrive no later than June 7 and we will read it at the Class Banquet.

Charlie Lawrance wrote in January: "Still breathing and happy about that. We have acquired two great-grandchildren and they visited us last summer, to our great joy and delight. We look forward to our 1977 Reunion!".... Nat Warshaw sent us a newspaper clipping in which we note that Dan Comiskey was appointed by the Board of Selectman to Needham's Council on Aging. Dan has been Co-Chairman of the Senior Shop-

per Bus Program since it started four and a half years ago.

Leonard "Bez" Besley wrote: "Have no news of significance, the years roll on, my health is good and my wife, Agnes, and I are well and happy and enjoying this cold winter in Florida." . . . Miguel Marquez writes from Chihuahua Chih, Mexico: "Indeed sorry to receive the notice about Harold Dodge — the circle is getting smaller." . . . Willard Brown and Dorothy "consider ourselves two lucky persons — recent physical check-ups showed nothing of import, so we continue our very active lives."

Cy Guething sent us this colorful report from Birmingham, Mich.: "Have had lots of snow in these parts this winter, but it hasn't been all that bad. We took advantage of some of it with a sleigh ride in a two-horse pung at the Dearborn Inn in Dearborn. It was uneventful except for an explosion of precious natural gas from the left horse and the soiling of the whipple tree. And now Gypsy and I are wishing that you all 'keep breathing' for a long time to come. We hope to see you in June at our Reunion."

Ellsworth "Pat" Patterson, '19, called recently to tell us that he worked with Harold Dodge at Bell Labs and that he is writing a personal tribute to Harold for the June issue of the Quality Control magazine. . . . Had a nice card recently from Beatrice and Walt Binger. At our reunion last June, Walt reported that he was still participating in fox hunts, jumping on horseback over stone walls and fences with relative ease.

We regret to report the death of **John Whitaker**. His widow, Edna, notified us in a recent letter that he died in August, 1974.

Hope to see you at our 61st Reunion. Keep your letters coming. — Ralph A. Fletcher, Acting Secretary, West Chelmsford, Mass. 01863

### 17

By the time these notes are read our 60th Reunion will be upon us. Information of the Technology Day events will have been broadcast as well as our Class programs for campus and the Cape. So about all there is to say now is, if at the last moment you are able to come, by all means do so. It promises to be an exceptionally good time.

From time to time **Jim Flaherty** has generously given his watercolor paintings of different M.I.T. subjects, which have been much appreciated. Now as some of us change our homes and locations a need to part with some things presses in. These watercolors could be among them. Warren Seamans says that the M.I.T. Historical Collections will be glad to receive such donations. Recently **Stan Lane** gave his picture and received an appreciative note of thanks. If any others wish to give a Flaherty original to M.I.T., it will be gratefully received and used.

Many of us have enjoyed reunions at the Northfield Inn. With regret I report the news that the contents of the Inn have been sold and the 88year-old structure is being torn down.

The Boston Globe recently ran a Charles Lindbergh feature with a large picture of the 'Spirit of St. Louis.' Sitting on top of the plane was a young man emptying a five gallon can of gasoline into the plane's tank. It could only be and was our **Ken Lane**, replaying his roll in that historic flight of 50 years ago.

The March meeting at the Chemists Club in New York saw more '17ers than '16ers. Dick Loengard enticed Bob Erb to come in from Connecticut by telling him that it was the last time a '17 septuagenarian could be seated. So Bob was there along with Enos Curtin, Clarence Seely and Dick. St. Patrick's Day was a big one for Bob as it was his 80th birthday. So it was a celebration well taken care of.

The four students who have been receiving assistance from our Aldrin Scholdrship Fund have progressed well during the school year. It is expected that Owen Knox, '76, of Portland, Me., will finish his delayed graduation and go on to medicine, as will Allen Glombiki, '77, of Chicago. Michael Solis, '78, of New York City also expects a medical career. Paul Lagace, '78, of Lewiston,

Me., is our Aldrin Scholar and continues in Aeronauties and Astronautics.

The Plainfield, Indiana, Jaycees have presented a posthumous award to the widow of Raymond Ramsay in further recognition of her husband's extensive civic activities. — Stanley C. Dunning, Secretary, 6 Jason St., Arlington, Mass. 02174; Richard O. Loengard, Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

### 18

The time lag is obvious between the receipt of your welcome Christmas cards and the publication of the news conveyed in them. I hasten to acknowledge greetings from Charles Dimock, and as usual from Mal Baber. Thanks to Mrs. Jane Franklin, here is news about her father, Wilfred Holt: "Thank you for your card to my Dad. He is hale and hearty for 79 years of age though his memory is poor. He still drives locally, and I live next door to him and fix his meals. My sister and brother also help out. My mother passed away March, 1972. Daddy is not too active, after years of staying in with mother; he mostly reads and works 'fill-ins' and watches TV of course. I play canasta with him. I think he will be around for several years yet.

"Among his accomplishments are: as an employee (chief chemist of Cellophane Lab) at DuPont plant at Old Hickory (transferred from Buffalo, N.Y., in 1929) he was president of the Old Hickory Employees Credit Union for many years and also served as president of the Tennessee Credit Union League, and for 17 years was a director of the Credit Union National Association. He is an elder of the First Presbyterian Church, Old Hickory, and still drives there every Sunday. He is a member of Old Hickory Lodge #598 F & AM, a past Master of Mt. Juliet Lodge (Tennessee), a Scottish Rite Mason and a Shriner. He only gets to Lodge about once a year now."

Clarence Fuller sent along with his letter a photograph of Course XIV Class of 1918: "I'm a bit slow in getting out my Christmas greetings this year. Dot started on hers in October and mailed them all early in December! She was trying to set a good example for me but it didn't take. She is doing okay with contact lens in left eye, but they won't operate on the right eye yet due to cardiac condition, angina, etc.! I still take three pills a day to keep my pumper going. I can't do much without stopping to rest frequently. So neither of us have any ambition to set the world on fire!

"You suggest some antique news, such as going back to 1918. Well, I've been cleaning out the collection of stuff in the attic but have stopped now due to the very cold weather. I did run across some souveniers of M.I.T. days and one in particular might interest you. It is a photo of Course XIV members (Electrochemistry) sitting together on the front steps of the new M.I.T. There were 14 of us."

Dave McFarland writes, "It was nice of you to remember me with a Christmas card. I had not heard from Jim Todd for a long time but had a pleasant surprise to receive a card from him. However, it had the bad news that his wife had been in an automobile accident and had some severe injuries. He said she was improving and now able to move around with a walker. Jim is partly retired as an officer of Harveys Department Store in Nashville, Tenn. The last time I had heard from Jim he was having some trouble with his heart and I have been worried about him. Jim, Dick Wilkins, and Bill Ryan were all great persons and good friends of mine at M.I.T. Bill and I lived together on Hemenway St after World War I when we returned to school. I saw Dick several years ago at Summerville, S.C., on our way to Florida. He seemed fine at that time and I was surprised to hear of his death not too long after I visited him.

"In 1971 my old company, Atlas Powder Co., was taken over by I.E.I. of Great Britain. The F.T.C. made them dispose of the Explosives Dept. which was bought by the Tyler Corp. of Dallas, Tex. A year or so ago they moved the Atlas Explosives Department headquarters to

Dallas, Tex., so many of my old friends had to move. Guess I was lucky that I was retired so I did not have to move. I still live about two squares from where I was born and am a fourth-generation West Chester native."

Bill Laskey's newsy letter follows: "For one who will be 82 on January 2, my health is reasonably good: I can still drive the car and can walk, but driving is easier. Looking ahead to the future I am dismayed and find little comfort in looking at a past that got us where we are now. However, avoiding a discussion of politics, I'll make this just a quick look at my past over the period before and since 1918.

"I was born in Chicago, III., January 2, 1895. Preparation for M.I.T. began at the Lane Technical in Chicago, the second year was at the Brookine, Mass., high school, and I completed at Chauncy Hall in Boston. I entered M.I.T. with the Class of '17 in electrochemical engineering, but later went to electrical engineering and naval architecture. I was commissioned Ensign during World War I.

"In the fall of 1919 I started work for the Engineering Department of the Western Electric Co. (which five years later became BTL Inc.). My work concerned the development of telephone apparatus. When I retired on January 2, 1960 at age 65 my service totaled 38 years. Married in 1920, we had a daughter and a son, who was taken by cancer in 1975. There are now five adult grand-children and two infant great-granchildren.

"From what I remember, Brookline, Mass., is beautiful with impressive hills, shaded streets and lovely homes. Presume I'd see some changes today but expect the hills are still visible. Hope that this finds you in good health."

One of my Christmas exchanges took an unusual turn as these two next letters from Larry Allen prove. "Dear Max: I have heard from you for two successive years, but for the life of me, I can't recall when and where our paths crossed. Was it in Waltham High School, M.I.T., IBM, or where? At 82, my memory is not what it used to be. So please refresh my memory as to your identity." And, later.... "You have undertaken quite a project! My biography is quite uneventful, but here goes: General Radio (Chief Draftsman); Signal Corps, U.S. Army; Miller Candy Co. (Plant Manager); Food Machinery Corp. (Assistant Export Manager); IBM Corp. (retired in 1959 after 27 years service); Gindoff and Swartz, certified public accountants (12 years); now finally retired in Glendale, Calif. I can truthfully say that being a graduate of M.I.T. opened the door to each position which I held, and that M.I.T. training was responsibile for my success in each position.

Jason Abrams spent some time in Montana last fall but returned to his beloved Bishop, Calif., by

Christmas interested as always in its ecology. This year's severe drought in that locale is only a further challenge to his courage and intellect. I am happy to report that his Evvie has recovered from a sprained ankle... An editorial by Roscoe Drummond in the Christian Science Monitor makes reference in a most approving manner to the work of Bill Foster as head of the Arms Control and Disarmament Agency under Presidents Eisenhower and Kennedy.

Through the courtesy of Mai Baber comes the enclosed notice of the passing of Bill Wyer: William Wyer died February 22, 1977 in Locust, N.J., at the age of 81. After graduation from Yale he attended M.I.T. and the Harvard Graduate School of Business Administration. He served as a 1st Lieutenant in the Corps of Engineers, U.S. Army. He held responsible positions with Western railroads until he formed the consulting firm of William Wyer and Co. (later Wyer, Dick and Co.) of East Orange, N.H. He was a member of the American Railway Engineering Association and a Director of the Astro-Science Corp. and the Tenna Corp. He was active as a consultant in railroad merger plans. He has written articles in Railway Age and other publications. He belonged to the University Club of New York, the Navesink Country Club and the Rumson Country Club. His outstanding hobby was duplicate bridge. He is survived by his wife, Kathleen, two sons, a sister, and four grandchildren."

The sad news of the loss of **Sidney Blaisdell** was conveyed by his wife, Eleanor: "Sidney had developed anemia a couple of years ago which followed a bad case of shingles. He had lived a very normal life, and looked well, so it was hard to believe he really had a serious condition. He enjoyed his reunion last summer and I am so glad he was able to attend. I feel sure he knew it was to be our last summer in New England. Our last five years in the beautiful area has been everything we could wish for." Sidney was a wire and cable engineer and manufacturer and was president of the Edmonds Co. and the S.S. Blaisdell Machine Co. from 1939 to 1966.

Charles Walker, '49, reported the death of his father, Albert C. Walker, on January 3, 1977. Mr. Walker served in the Chemical Warfare Service during World War I. He was working on gas mask design under Warren K. Lewis at M.I.T. He had been a chemical engineer for Bell Laboratories, a director of the Textile Research Institute, and was awarded the Louis Edward Levi Medal by the Franklin Institute. He was best known for the development process for synthetic production of quartz crystals used in telephone equipment. — Max Seltzer, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; Leonard Levine, Assistant Secretary, 599 Washington St., Brookline, Mass. 02146

### 19

Ralph Gilbert was heard from through a friend of his who called here recently....Also George Michaelson had lunch with your secretary while he was in Florida.

Robert B. MacMullin received the Electrochemical Society National Medal and citation for 1976 at Washington, D.C., on May 4 for his contribution in engineering and technology in electrochemistry.

Aubrey P. Ames, 1980 Washington St., San Francisco, Calif., writes in February, "News from Aubrey Ames! Not too much, as I am very much retired. It would be appropriate to call me Mr. X, as I am ex-about everything. Recently I have had a spill of collecting 50-year awards, the most recent being one for 50 years a member of the A.S.M.E. In 1971, I became a 50-year member of the Shriners. I dropped out of S.A.E. after 30 years and the A.O.P.A. (airplane pilots) after 20 years - some others after shorter periods. Have dropped out of all sports except golf - and do very little of that - due chiefly to lack of ambition. Several years ago we had here (California) an M.I.T. luncheon group, but it seems to have gone out of business long ago, so there is nothing here to bring M.I.T. graduates together. Due to my 28 years in foreign service and 30 years on the west coast, I have gotten pretty much out of touch with everything pertaining to M.I.T. but have not lost interest.'

Tim E. Shea responded generously to my request for notes. "I think these are my first ones ever. I have led a full life. After graduate study and teaching at M.I.T., and a year in manufacture at Chicago, I spent 18 years in Bell Laboratories on electrical networks, sound recording and reproduction, and central office switching. One result was a book, Transmission Networks and Wave Filters, which is in active use after 47 years.

"During World War II I was Director of War Research for Columbia University, and established three O.S.R.D. laboratories, including the Navy Underwater Sound Laboratory. I traveled incessantly, especially in the Pacific. This work is mentioned in Vannevar Bush's book, *Pieces of the Action*, and in James P. Baxter's history, *Scientists Against Time*. I received the Presidential Medal of Merit and honorary doctorates from Columbia and Case Institute of Technology.

"In the postwar period, I was president of Teletype Corp., Vice President and General Manager of Sandia Atomic Laboratory in New Mexico, Vice President of Bell Laboratories, Eastern Manufacturing Vice President of Western Electric, and later Engineering Vice President of Western, as well as a Director of Western and of Bell Labs. I started the Western Electric Engi-



Members of the Class of 1918 in electrochemical engineering (left to right): Morris R. Caust, Chuan Y. Hsu, Jacob Balyozian, Paul McAllister, Harold V. Atwell, Clarence C. Fuller, John R. Fuller, Albert R. Mumford, Rolf Knudsen, Rolfe A. Folsom, H. F. Germain, Julian M. Avery, Alan B.

Miller, Arthur S. Johnson.

neering Research Center near Princeton, the company's internal Graduate Engineering Program, and its computer systems organization.

"While at Sandia I was President of the Albuquerque Community Chest. For community and charitable work there I received Papal Knighthood in the order of St. Gregory. I was a member and chairman of the Engineering Council of Manhattan College for 13 years, have been a fellow of several engineering and scientific societies, and a member of the National Academy of Engineering since 1967.

"Retiring in 1963, I spent half-time for eight years as chairman of the Undersea Warfare Committee of the National Academy of Sciences. For this work I received the Navy's Distinguished

Civilian Service Medal.

"My wife Norma and I spent three months traveling around the world. We are fortunately both well, and recently drove to Houston for Thanksgiving. We are now thinking of a trip for our 55th wedding anniversary in 1977. We have had six children and 22 grandchildren, and a main effort now is to help some of the latter through college.

"I do not think I have seen a classmate since Lloyd Sorenson at Newport News Shipbuilding Co. in 1965. As you can see, my interests have pulled me in many diverse directions, and continue to do so. Associations have made me feel as if I have had about six alma maters, each of which has passed me on to the next for further learning. We never need to stop learning and doing, do we? After all, Michelangelo designed the church of Santa Maria degli Angeli in Rome in his 90th year."

Pierre Blouke, P.O. Box 278, Chatom, Ala.: "On retiring in 1967, I spent a year abroad with my wife and daughter before establishing residence here. We have one son who has his doctorate in solid physics and is now with Texas Instruments; a second son with a doctorate in clinical psychology who is now in Helena, Mont.; also a daughter with a master's degree who is married and living in Houston; a youngest son who is a lawyer with the I.R.S. in Boston, Mass; and the youngest a daughter, sophomore at the University of Alabama. We had a nice herd of Angus Cattle which we sold the last a year ago. I indulged in commercial catfish two seasons, and am now a tree farmer. We have had many visitors from different states of the Union, Mexico, etc." Our records show Pierre Blouke graduate in architecture, won a scholarship in 1921 and attended American Academy in Rome, Italy and spent some of his career in Chicago, III.

George Bond, Jr. from Paulsboro, N.J., writes — "Good to hear from you down in sunny, not too warm Florida. We are having a real old-time winter up here with plenty of snow, frozen pipes, etc. I spent christmas visiting my older daughter and family about 20 miles above Boston with plenty of snow there also. Last summer at my cottage on Long Beach Island I entertained all ten of my grandchildren at one time, a thrilling experience. Two of them are now in college, in N.H. and Delaware. I am still very busy with all my community activities and also am enjoying trips to many European countries. I am planning another trip abroad in April to Greece and its islands. I enjoy excellent health."

Horace W. Denison, 423 Plain St., Stoughton, Mass., writes, "Thanks for your card. I buried my beloved partner a month ago and am a very lone-some old man. Hope to see you soon." Denny retired from J.W. Wood Elastic Web Co. in Stoughton... James W. Reis, Jr. from Los Angeles writes, "Just got back from Las Vegas where I celebrated my 81st. I didn't try to 'Buck the Tiger' but I still sure enjoy the night life."

Leon I. Snow from Sarasota, Fla.: "If you ever get to Sarasota, give me a call. It would be nice to see you." ... William H. Vogt, Jr. writes from Rochester, N.Y., "I retired from Taylor Instrument Co. in 1961 where I spent 26 years as designer of instruments, manager of methods engineering and division superintendent of manufacturing. My wife passed away in 1974. I have one daughter who obtained her Ph.D. in geology at the University of Glasgow and one son who is a patent attor-

ney in New York City."

**Dean Webster**, 344 Scottsdale House, 4800 N. 68 St., Scottsdale, Ariz. (winter address), writes, "Nina and I are as well as can be expected at our age. We have acquired a winter home in Arizona and will stay here until May 1. A good winter to be away from the northeast! Nice weather here — 45 degrees in the morning and 65 to 75 degrees by noon. Bright sun every day and no wind. Average age in our surroundings is over 70. Best greetings."

Henry A. DeBonneval, 43 - 5th Ave., New York, N.Y., writes, "Served on International Committee of New Jersey Bicentennial Commission. Weekly visits to my daughter in Rumson, N.H., where she is a trustee of Monmouth Day Care Center and serves on parents' council of Rumson Country Day School and on board of F.I.S.H. November visit to other daughter in Santa Monica, Calif., where her husband, on leave from the University of Massachusetts, is completing his second novel. I worked also with Sister Margherita Marchione of Fairleigh Dickinson University on a translation of the works of Philip Mazzei, a friend of Jefferson, from French to English. I have retired from engineering work."

Eilliot D. May died on January 12, 1977 at Winchendon, Mass.

Your secretary attended the M.I.T. Florida Festival at Orlando-Hyatt Hotel, attended by close to 300. Speeches by Dr. Robert Mann, Tom Jones and Dr. Harold Edgerton were followed by cockails and dinner and a banquet address by President Jerome B. Wiesner on Saturday, February 19 and a trip around the operating areas of Disneyland was conducted by Tom Jones, Manager of Operations, on Sunday morning, February 20. Best wishes to the class for a good summer. — E.R. Smoley, Secretary, 50 East Rd., Delray Beach, Fla. 33444

20

A distinguished classmate, William S. Johnson, has left our ranks on January 5. After obtaining his Ph.D. in organic chemistry at the Institute he joined the research laboratory at General Electric in Schenectady and then became associated with Rohn and Haas Co. where he was put in charge of the development of Plexiglas. He was appointed Director of Research and, later, Technical Director of Foreign Operations until his retirement in 1962. He was a member of the American Chemical Society for over 50 years, a member of the Academy of Sciences and the American Association for the Advancement of Science and of the Alpha Chi Sigma Fraternity for professionals in chemistry. He leaves his wife, Esther, two daughters and two grandchildren. His home was in Philadelphia, 10895 Crestmont Ave.

It was pleasant to run into **Henry Hills** at a local gathering, and especially pleasing to report that he was looking hale and hearty. I used to see Henry at the luncheon meetings of the M.I.T. Club of Boston where he was a faithful attendant, but must confess that this severe winter kept me from recent meetings, attractive though they were.

Josh Crosby, '21, Secretary of the M.I.T. Club of Southwest Florida, tells me of the Club's appropriate and thoughtful action in making Lucille Hall an Honorary Life Member of the Club, "in appreciation of the invaluable support and the gracious hospitality which you and your late husband, Clyde, extended on many occasions to the Club."

Since "hope springs eternal" your secretary had the optimistic, but apparently unwarranted thought, that the dissertation on "Life begins at 80" via **Bob Sumwalt**, might get a rise and response from some of you. In previous issues of the class news, I have also requested, nay beseeched, news of great-grandchildren, of which there must be a considerable number. Do you not take pride in reporting such a significant family event? At any rate, it would do much to cheer up this old codger to get some mail from you. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

21

Your secretary is now back at home base with numerous jobs calling for attention including a classnotes deadline. We had five good weeks in Sarasota, Fla., which included various '21 luncheons and cocktail parties. Two dates stand out because they involved a number of classmates, but they were all fun and with lots of sociability. One evening, Millie and Herb Kaufmann entertained at cocktails and the hors d'oeuvres were fabulous. Claudia and Josh Crosby, Alice (Mrs. Robert) Felsenthal, Beth and Whittier Spaulding and the Haywards were there. I learned that Herb Kaufmann is still active in civic affairs on Siesta Key. The Kaufmanns have bought a house in the mountains of North Carolina and plan to spend summers there. The other date was a luncheon at one of Sarasota's fine restaurants attended by an even dozen of us. Rufe Shaw drove up from Sanibel Island and Graciela and Heller Rodriguez came down from Tampa. In addition, Kay and Larcom Randall were there, as were Jim Parsons, Tom Dutton, the Crosbys, the Spauldings and the Haywards. I learned that Tom Dutton has retired from the brokerage business. The Shaws' home in New Jersey is now completely rebuilt after having been vandalized and set on fire last June. Rufe reported that he recently drove down to Naples, Fla., and had lunch with Phil Coffin. Phil "looked and acted well." Staying at the same Island Inn in Sanibel while the Shaws were there, were Betty and Howard W. Johnson, our honorary classmate. Rufe said he saw Betty and Dugald Jackson when they first arrived in Florida this winter and was shocked to learn that Dug had had several operations since our reunion last June. He lost two discs in his spine and now uses a walker to get around. Quoting Rufe, "His brain is still as keen as ever and he is good company at the dinner table."

Alumni Fund envelopes from six classmates brought in welcome news. Merritt Farren of Lakewood, N.J., wrote, "Now that we have moved to Leisure Village, I hope to prepare an outline of an interesting life. In June, while visiting our son and his family in Los Angeles we had lunch at his club and a tour to see his creative work. We also saw Leila and Sam Lunden in their home high above the city." A further letter from him said in part, "my not keeping close to alumni in New Jersey is my own loss. My business was in New York and I joined the M.I.T. Club there and occasionally attended meetings. All the speakers were engineers, talking on subjects foreign to me as an architect, and I lost interest. The Depression of the 1930s hit architects very hard and directed many into other fields."

Elmer Campbell of Seminole, Fla., wrote, "Last September as National Adjutant of Retreads (Veterans of both World Wars), I attended our 29th annual National Convention in Portland, Ore. My wife Becky and I flew to Los Angeles, rented a car, drove through Beverly Hills, Hollywood and Laurel Canyon, then on to San Simeon to visit the famous Hearst Castle. Then on to San Jose to tour the Winchester House of 160 rooms constructed during 38 years of continuous building. The Winchester widow believed that as long as carpenters continued hammering she would never die, but she died at 82. We also visited Bonnerville Dam, saw the salmon runs, Multnomah Falls and the Lodge on Mt. Hood with glaciers nearby."

Laurence Buckner of York, Penn., writes, "Hey, Sumner! Be the first to print the whole song of 'Take Me Back to Tech.' I forget practically all but the tune. Sometimes I can sing when the work load isn't heavy." [Buck, I think I can remember all three verses, or was it four? How about the rest of you in our class?] ... L. Willis Bugbee, Jr., and his wife, Justine, celebrated their 50th wedding anniversary by a two-week cruise up the Mississippi and Ohio Rivers from New Orleans to Cincinnati aboard the Delta Queen. Congratulations to you both! Will is still practicing law in Detroit. Your secretary has also cruised on the Delta Queen and found it delightful.

Theona and Albert Genaske of Fryeburg,

Maine, took their fourth AARP tour last August, this time to the Canadian Northwest. "We visited nephews and nieces I had never met - all married with families. We two are part of the Mt. Washington Valley Square Dancers and do lots of exhibitions in Colonial costumes." . . . Ernest R. Gordon writes from Grand Junction, Colo., "I stopped consulting more than a year ago. I have become a good yardman at my Colorado resi-dence where all '21ers will be made welcome. I continue to travel which has led to guite an interest in Meso-American archeology.

My appeal for news to 15 classmates in the January class notes brought forth seven replies, one from a man whose name I had not picked out in my random selection. Doane Greene of Rock Hall, Md., wrote, "You asked for it. So here goes: I am now the oldest enrolled 'student' in the youngest college around here. Chesapeake College, about 40 miles from here started to function around 1972. My son discovered they had an evening course called 'Family Fitness,' and we enrolled. My granddaughter, aged 11, goes with us. She is probably the youngest enrolled student and is in the fifth grade here at home. A young shapely Swedish girl teaches the class. When she saw me she assigned an assistant as my private instructor (or guardian). The course consists of a lot of special 'Calisthetics' and everyone has their pulse taken after each strenuous exercise. I did all right. When finished we all were allowed in their fine big swimming pool. Of course, I tried the diving board and then foolishly opened up and sprinted the length of the pool and back. [Doane Greene was captain of the swimming team at M.I.T.] What a big mistake! At once my status changed from the oldest student to the oldest instructor in the youngest college. They all asked me to teach them to swim like me." Doane is still actively sailing his Columbia Sabre and enclosed two clippings covering races in which he placed first and second.

John T. Rule reminisced at length about John Barriger who died last December. "I was in his wedding party in St. Louis in 1926. We attended high school together and he was a railroad buff from about age 10. In our junior year in high school he had a beat-up car of some kind and whenever feasible after school, we drove across the river into Illinois, parked beside the Pennsylvania tracks and watched the crack flyer from St. Louis to New York go by. This, to John, was heaven. To me it was a chance to ride in an automobile. In March, 1917 John had to take college boards to get into M.I.T. I was all set for Princeton. Johnny suggested I take the C.E.E.B.s for practice. Since M.I.T. required a course in high school physics he offered to tutor me to sharpen himself for the exam. I took the exams, applied to M.I.T. and forgot the whole thing. A telegram caught up with me in August while I was camping in Montana saying I had been admitted to M.I.T. Incidentally, my physics grade was 62.

"When I was Dean of Students around 1960 my good wife told a group of students I had never graduated from high school (true). For weeks after, I received match covers with spaces to apply for a correspondence course leading to a high school diploma.

'John had a remarkable memory. In a course

we took together, the professor successively showed photographs of 50 prominent people, naming each one. He then shuffled the photos and held them up one at a time. I was proud to get 30 correct answers. John named all 50. John took thousands of pictures of just plain receding railroad tracks from the back of every train he ever rode. Shown any one he could tell you within a mile or two where it was taken. During World War II. I was stuck one day on a bench outside the

Southern Pacific station at Indio, Calif., waiting for a train to Los Angeles. A passenger train came through going east. On its rear was a private car, and on the back platform was Johnny Barriger with a camera up to his eyes. I waved and shouted but Johnny went on photographing until the train had disappeared. John lived, breathed, and slept railroads every day of his life.

"Santa Fe is a delightful place to retire. It is urbane and sophisticated, but largely literary and artistic as opposed to scientific or professional. Consequently, we see almost no M.I.T. graduates. We were in Mexico a year ago with Andy Kellogg, 24, and are planning to go to Boston in May to renew old acquaintances. I do the usual things, serve on a board or committee, read a lot but don't write letters to the editor. Then, every five years, I write a reminiscing letter to my class secretary." Thanks, Jack, for a wonderful letter!

Elliot Roberts of Westmoreland Hills, Md., wrote, "You didn't mention wanting to hear from me but I'll write anyway. I have been retired from my professional work for the Coast and Geodetic Survey for 15 years now. I keep fairly busy with committee work for my Club — the Cosmos Washington. We're preparing an in-depth centennial history for our 100th birthday in 1978 which gives me the opportunity to exhibit my writing style. I also get an article into some magazine once in a while. Dick Smith is a fellow member of Cosmos and we see the Smiths occasionally. Becky and I love music and enjoy symphony, opera and ballet at the J.F.K. Center for the Performing Arts." Thanks, Elliot, write again.

Wallace Adams of Middletown, Ohio, now has his first great-grandchild, a boy, and another one due in June. Writing in late February, Wally said, "We certainly got out share of bad weather and are still restricted on gas supplies. I only played golf once since Thanksgiving until this week, the longest I've been off golf courses in the 13 years since I retired."

Glenn Fargo wrote, "My wife and I like to travel but as we grow older our enthusiasm seems to decline. Last year we sailed from Tampa to Honduras and Yucatan to see some Mayan ruins. The Stella Solaris was a fine ship and we enjoyed the trip very much. Several years ago we took an Aegean cruise on her sister ship, the Stella Oceanis. We have been to Europe seven times but are not planning to go again. Last fall I had a serious operation because of a ruptured esophagus, which caused an abscess on my left lung. My surgeon gave me a final examination this week and said everything was fine. I walk about one-and-a-half miles each day to keep in shape. We have lived in St. Petersburg 25 years and still enjoy it, but it no longer has the nice atmosphere of a small city."

The final letter in response to my plea in January was from Augustus Kinzel in La Jolla, Calif. Wrote Gus, "An open request in print is a command. [I wish others thought so.] I'm living in La Jolla and working in New York where I keep an hotel apartment permanently with a duplicate of everything, so I commute with a briefcase. I'm trying to cut commuting to once a month but with only partial success. I'm still on the Board of the International Institute for Medical Electronics and Biological Engineering which takes me to Paris on occasion. I'm on other boards and some special committees for Caltech. I have fun with trick inventions. These include a Self-Making Bed, a Ceiling Bed which is an improvement on Tom Jefferson's, and an accordion-type Swimming Pool Cover, just to mention a few for which I am trying to find a license. In addition to visiting children and grandchildren. I manage to lead a normal social life. I get to Queechy Lake in the Berkshires, during summers, where I sail a Sunfish and a Laser. I also have one of each at La Jolla.

The Barriger family hope to establish a John W. Barriger III Professor of Transportation Fund at M.I.T., to which contributions would be welcome. Sumner Hayward, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; Josiah Crosby, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; Samuel E. Lunden, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

Greetings from snowy Buffalo, but it's all melted now and beautiful. We appreciated Yardly Chittick's card from Captira Island. He had chilly days, but no cold ones. . . . Elizabeth and Warren Howland celebrated their Golden Wedding Anniversary in Lafayette, Ind., on December 28, 1976. Their elder son, Bradford, now a doctoral candidate at M.I.T., took his parents' picture for the local newspaper. Their younger son, Howard, is on leave from teaching at Cornell University, with his wife, Monica, and their son, David, 7 years old. They are in Cambridge, England, having spent five months in Germany. Howard has two older sons, Frank and Jacob, now college age. The Howlands plan a second celebration in June of this year. Warren still accepts small engineering jobs, while Elizabeth is enjoying the sale of her first book.... C. George Dandrow, industrial marketing consultant of Gilmore Pond Rd., Jaffrey Center and Bronxville, N.Y., was one of the honorees at a recent M.I.T. Corporation Luncheon given to praise the dedication and accomplishments of the former Presidents of the Alumni Association of which Mr. Dandrow was the 55th. Mr. Dandrow, who was joined by his wife, Catherine, at the luncheon, retired from Johns-Manville in 1964 as vice president and general sales manager after a 42-year career in engineered products to the industrial and utility fields.

Charles C. Bray of Western Springs, Ill., writes that he is 80 years old this year. He is a Building Materials Consultant and a veteran of World War I.... Edward A. Merrill of California is retired from Skidmore, Owings and Merrill, Architects and Engineers. He is now living on Nob Hill and enjoyed San Francisco with mild professional activities in the American Institute of Architects (Member Emeritas) and the American Society of Civil Engineers (Life Fellow). Ed's hobbies include chamber music (viola) and Bohemian Club orchestra. Also Sherlock Holmesiana (Baker Street Irregulars).

Randall E. Spalding of New Hampshire sends the Class an invitation as follows: after enjoying four days of Reunion (55th) festivities at Cambridge, the Class of 1922 will proceed to the White Mountains of New Hampshire for a "post reunion" of several days at the Spalding Inn Club, Whitefield, N.H. — Mr. & Mrs. Randall E. Spalding, Hosts. . . C. Randolph Myer, Jr. of New Hampshire is managing a business. He enjoys skiing, tennis and gardening. . . . Ronald G. MacDonald is still active as Senior Editor of Southern Pulp and Paper Manufacturer published in Atlanta, Georgia. . . . William H. Mueser of Bedford, N.Y., retired from his firm in December of 1975, after being with the firm 52 years.

The sympathy of our Class is sent of the family of Roscoe E. Sherbrooke. Roscoe was a retired part-owner of the Quincy Market Cold Storage and Warehouse Co. in Boston. He was also a former water commissioner and a member of the Conservation Committee. He had been the chief engineer of Quincy Market before his retirement several years ago. Roscoe was a native of South Bend, Ind., but had lived in Cohasset for the past 40 years. He was past Commodore of the Cohasset Yacht Club and past President of the Cohasset Historical Society and member of the Harvard Alumni and Business Club. He was a World War I veteran and member of the George Mealy Legion Post. He is survived by his wife Virginia; a son Ross; a brother, Herbert; and two grandchildren. . We also send the sympathy of our Class to the family of Russell W. Lowry of Canton, Mass.

Keep happy and healthy and honestly trying to be at our 55th - Whitworth Ferguson, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; Oscar Horovitz, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

I have sent your comments on the proposed 55th Reunion plans for June 8-11, 1978, in Cambridge to our Class President, Charles M. Mapes. He resides at 19 Mile Rd., Suffern, N.Y. 10901. I know he will be interested to hear from you. He has selected and appointed Royal Sterling, who resides in the summer at 1340 Warwick Neck Ave., Warwick, R.I., 02889, as Reunion Chairman. He is not yet ready to receive registrations so please don't jump the gun on this until you receive the first bulletin a few months from now.

George F. Nevers says he keeps busy with "Hobbies — gardening, hunting, sleeping, eating, waiting for next Social Security check — and some traveling (to Florida, mostly). I'm distressed that so many of my buddies have stopped breathing." ... Fron Heritage Village, Marge and Tom Rounds report their five-week trip to California, ending with a two-week cruise through the Panama Canal. They are about recovered from the cold weather shocks of January. Tom asks whether anyone else has suffered frostbite on a badly sunburned and peeling nose. It was 90° at the last port of call, San Juan, P.R., and 15°F a few hours later in New York, with a howling north-west wind of at least 30 knots. You figure the chill factor; I prefer to forget it.

From Mrs. Herbert C. Button (Sarah H.) we learned of the death of her husband on October 4, 1976, at his home in Manlius, N.Y. A long-time resident of N.Y. State, Bob prepared at the Hackley School in Tarrytown, N.Y., and entered M.I.T. in the fall of 1916. In 1917 he joined the U.S. Navy and after discharge in December, 1918, entered with our class and was graduated in Business Administration in 1923. He was a member of Sigma Alpha Epsilon. After graduation he became successively a securities analyst and an investment counselor. During the 1930s he became associated with the Curtiss-Wright Corp. and during the war became a flight test inspector. Later he entered social service work in the Onondaga County Department of Social Services. Until his death he retained his interest in market

From, the Alumni Association office we hear that Joseph K. Preston of Wilbraham, Mass., passed away on May 7, 1976. He prepared at Lynn (Mass.) Classical High School and took his B.S. degree in Chemical Engineering with us and later his M.S. in Chemical Engineering Practice. After graduation he joined A.G. Spalding and Brothers and became factory superintendent and factory manager in Australia. Later he returned to the U.S. to become Divisional Assistant Manager and later Research and Development Manager. Later he was Project Manager with Titeflex Co. His last move was with Tampax, Inc., where he was foreign branch supervisor. - Thomas E. Rounds, Secretary-Treasurer, 990A Heritage Village, Southbury, Conn. 06488.

24

Here in New England, living contiguous to the Institute, our enthusiasm is increasing solidly for Ed Moll's Mini-reunion at Old Sturbridge Village, June 10, 11 and 12. The fertilizer is the contemplation of renewing classmate acquaintances, in some cases 15 years. Of course, some optical device may be necessary, but to date we have intentions from Nellie and Hoyt Hottel, Hazel and George Glennie, Martha and Roland Black, Kathie and Dippy Davol, Rene and Ed Moll, Barbs and Frank Shaw, Marie and Eric Brater, Dolly and Ed Hanley, Helen and Dick Shea, Kathleen and Marshall Waterman, Don Moore, Dick Lassiter and Russ Ambach.

Allora and Clint Conway, Clearwater, Fla., boosted attendance at the second Florida Festival, February 19, along with Paul Schreiber, his wife, and Dick Jackson. Joe Lusignan was registered but not seen.

While on Florida, we are sorry to report the sudden passing on of Ruth, wife of **Curly Fletcher**, February 19, in the Indian River Hospital

after major surgery, according to a note from John Fitch, Vero Beach, Fla.

The Alumni Center of New York City reports the death of **Robert N. Vincent** in Teaticket, Mass., February 1, 1977. Our scant information indicates that he earned an S.B. in general engineering.

Short lines from the back of Alumni Fund envelopes: Rut Torres-Saravia, Guadalajara, Mexico: "Very pleasant meeting at Ft. Lauderdale last December. Greetings to all"; Paul H. Caskey, Rockford, Ill: "Retired — nothing much of general interest"; Percy H. Wilson, Carmel, Calif: "Still enjoying quiet life in Carmel"; Dave Evans, New

Canaan, Conn: "Historical Society, Librarian, Caretaker of the Town House and new library, member of Racqueteers — ten retirees playing tennis a couple of days a week — over 70 — unbeaten team." Wonder who they are playing — Yalies 1900?

President Frank Shaw received a letter from Howard L. Richardson, '31, of the Building 10 Sponsoring Committee, asking for help in soliciting the aid of classmates to achieve their goal of \$1,325,000. It will be used to create an Alumni Center by modernizing Room 10-250 and the area under the dome. "Would our class or a group of classmates consider a \$50,000 gift?" The purpose is to insure a continuing role of a strong Alumni Association by close contact of present and future Alumni and Institute Officers in a pleasant, convenient meeting place.

Your scribe, as an Alumnus of Course I, has received a letter from Professor Frank E. Perkins announcing a Civil Engineering Department (Courses I, XI, XVII) Reunion for the third consecutive year at 5:30 p.m. on Technology Day, June 10. The large attendance and enthusiastic spirit of the previous Reunions may well indicate that an

annual event should be scheduled.

Hood Worthington died February 14, 1977, in Wilmington, Del. He received his S.B. and S.M. in chemical engineering. In 1925 he joined the du Pont Company in Wilmington and retired 38 years later as director of the Technical Division of the Atomic Division. He was a member of the du Pont teams which, under the Atomic Energy Commission, directed the Hanford Engineer Works in Washington and the Savannah River Plutonium plant in South Carolina.

In August, 1964, Hood was cited by the Atomic Energy Commission for his, "outstanding participation in, and meritorious contributions to the mission of the U.S.A.E.C. For more than 16 years his vision, guidance, technical knowledge and devoted service to his company and the commission contributed vitally to the defense of his country." He was a member of many scientific and civic organizations, particularly drama, musical and horticultural. "Serry" will well be remembered for his performances in the Tech Show for four years. We extend our sincere sympathy to Martha, son John, and daughter Sarah. - Russell W. Ambach, Secretary, 216 St. Paul St., Brookline Mass. 02146; Herbert R. Stewart, Co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

25

It is hoped that the winter of 76-77 is finally loosening its grip (in early March). Ryders Cove, which we look out on from our living room, is finally clear of ice after being frozen solid for more than two months. This kind of winter weather is of course most unusual for Cape Cod where we boast that golf is played all year. A note in one of the local weeklies stated unkindly that "winter golf on the Cape will begin the first week of May."

An apology is owed to **William Stone**. In noting the '25ers on Cape Cod I have somehow overlooked him. He is living in West Dennis and I hope

Bill will forgive me for this oversight.

The February meeting of the Alumni Council was attended by five classmates. Jim Howard admits to having spent some time in Florida this winter and Courtney Worthington has visited his son in Caracas, Venezuela. Ed Kussmaul, Will Gardiner and I have stayed put.

Gil Noble loves retirement in Florida and keeps busy with his race-horses and stamp collection. . . . Edward Zetterberg living in Muncie, Ind., writes that his health permits no travel but he has continuing interests at M.I.T. where his grandson, Bill Dupont, '75, is pursuing graduate work towards his doctorate in chemistry. Bill and his wife are graduate advisers in Baker House in addition to their research and teaching. . . Milt Salzman continues a busy schedule with activity in village, churchwork and sports and particularly barbershop choral singing which has been a favorite hobby for a number of years. A tour with the international barber shop quartet organization took him to England, Wales, Belgium and

Germany where they gave singing performances and TV broadcasts in the major cities....Alan Crowell reports from Sarasota, Fla., that he continues to have an enjoyable retirement. He finds few '25ers among the large group of alumni in the area. He has been elected Junior Warden of St. Boniface Episcopal Church which involves him in supervision of buildings and grounds — a fairly demanding assignment.

The passing of **Dow Drukker** was noted in the March-April notes and since preparing that report information has reached me which indicates the wide interests and activities of Dow. He was President of Union Building and Construction Corp. in 1940, President and director of Drukker and Co. in 1955, President of Marion Company, Inc., in 1956, Secretary of Bleachery and Printing Co., Carlton Hill, N.J., from 1932 to 1960, Vice President and Publisher of the *Herald-News*, Passaic-Clifton, N.J., from 1942 to 1956, Vice President of Union Building and Investment Co. from 1936 to 1956, associated with New Jersey Broadcasting Co., Patterson, N.J., from 1942 to 1956, a Commissioner of the New York Port Authority from 1953 to 1958, served as trustee of Stevens Institute of Technology and on the Board of Governors of Passaic General Hospital.

It is with great sorrow that I have to report the passing of several classmates. Lt. Col. **Thomas Lee Howard** of Carmel, Calif., died at the Silva B. Hays Hospital at Fort Ord, Calif., on January 5, 1977 following heart surgery. The colonel was in civil engineering and we have no record on him

for several years.

As these notes were in preparation a letter was received from Barron P. Lambert, '26, stating that Henry C. Hoar had died on February 27, 1977, following a long illness associated with cancer. Hank retired to Williamsburg, Va., after many years with National Tube Co. For some time he had been actively cataloging old books for the William and Mary College Library.

Edwin T. Erickson died at his home in Waretown, N.J., on April 5, 1976, and Albert M. Prentiss passed away in Arlington, Va., on December 30, 1976. — F. Leroy (Doc) Foster, Secretary, 35 Woodland Way, P.O. Box 331,

North Chatham, Mass. 02650

26

It is unusual to be writing class notes mid-week, in the evening, but classmates provided the material this month, so this is an assembly job. I hope it continues because it makes it interesting for your secretary and also gives the class more news. Howard Humphrey has given the hows and whys of continuing life in the Wilmington, Del., area specifically Greenville - also you will recall that at our reunion he was pushing his wife around in a wheelchair. Here are excerpts from Howard's recent letter: "I can report that Virginia's ankle cast came off soon after our return from our 50th. but due to the seriousness of the fracture, progress has been slow, and she still has to have the screw removed. Because she also had to undergo a cataract extraction in January, our winter to date has been spent at home. However, we still have hopes of heading south in April, to at least gain some earlier spring weather. Your descriptions of the New England sea have a nostalgic effect on me with my North Shore background. Many of our friends expected we would return to New England, but having been here since 1937, it would be difficult to pull up roots put down over 40 years. While we do not look out over the sea, we do have a view of very beautiful Delaware countryside; 'Chateau Country' they call this area. Our 'Chateau' is a modified Cape Cod on two acres of what was formerly hillside pasture-land. There is plenty to do with two acres and I no longer try to do it all myself as much as I enjoy it. We hope to get back for Technology Day this year. Talking with a local alumnus who goes back for his 50th this year, I was reminded of the great time we had at ours, even though Virginia and I did it under difficulty." This is Howard's answer to Pigeon Cove. What is yours?

Recently Ralph Head wrote from Zephyrhills,

Fla. Here is part of Ralph's reply: "Zephyrhills is halfway between Tampa and Lakeland in citrus, rolling, country, not 'hilly' as we know it. I go to both of those cities to follow the market — investments — for myself and a few others, like **Charlie Snow** does, just to keep my old connection with Wall St. I love it. I wish we had annual reunions! That's what **Ray Mancha** and I really wanted."

We recently had a letter from Isabel Mancha asking for suggestions on the disposition of the tape recordings Ray made at the 25th and 50th reunions. As a result these recordings are now safely stored in the M.I.T. Historical Collections. An excerpt from Isabel's letter: "Raymond cherished his memories of his years at M.I.T. The friendships he made there have endured through the years and enriched his life. He enjoyed every minute of the 50th Reunion, and I rejoice that he had that happy experience."

As you know Elton Staples lives nearby in Orlando and when we had occasion to telephone him recently we learned that as a result of Miriam's passing he plans to sell the Cape Cod house. Orlando has been his legal residence for several years right near his son. Elton has a late spring European trip on his agenda and of course will be coming to New England later. . . . A note from Lou Taylor tells of his activities since the reunion: "Ruth and I are home again after two weeks traveling through Israel and another couple of weeks visiting friends in the Netherlands." . . . Roaming Dwight Woods indicates that he has not slowed a bit: "Still enjoying retirement and good health. Just got back from a three-week trailer trip to southeast Arizona. Going to South Padre Island to spend Christmas with son and family but we will stay until March enjoying surf, fishing and friends and trips into Mexico. Never a dull moment." ... Ralph Head mentioned Charlie Snow in his letter and we have a communication from Charlie as well: "Still carrying on private investment counsel work. Trustee and treasurer of one of the top public libraries in the U.S. Greatly enjoyed the 50th Reunion last June.

We cannot write an issue of class notes without some word from Pigeon Cove. Ruth's total hip operation is now five months behind us, the crutches have been replaced with a cane, and she is driving her car again. For 25 years, prior to these operations, Ruth's adviser on her arthritis problem was none other than our classmate Dr. Marion Ropes Fielding. The other evening I called her to report on the recent operation and much to my surprise found that she knew all about it from the class notes! Marion Ropes, as she is known professionally, has been a most dedicated and renowned arthritis authority at the Massachusetts General Hospital for a great many years and still goes to the hospital a couple of days a week to look after old friends. We were most fortunate to have had her valuable guidance for these many years. As for your secretary, a new dimension has been added to his life since the formation of a local swimming club at a new indoor pool. While our Florida friends were unable to swim in the cold ocean and unheated pools, we revelled in swimming on our backs and looking through the Thermopane at the snow piling up outside. Won't someone please challenge us on this?

Stark Draper's daughter Martha has recently been appointed a Regional Director of the Alumni Association. She was at the last Alumni Council meeting and talked with Bob Dawes who suggested that she send along the names of '26 men who attended the recent (Second) M.I.T. Florida Festival in Orlando. Marty advises that Charlie McHugh, Elton Staples and E. Newton ("Bull") Roberts were there. From all reports it was a gala affair with a guided trip behind the scenes at Disneyland and one of Harold Edgerton's super presentations. With that and a Cherriol — George Warren Smith, Secretary, P.O. Box 506, Pigeon Cove. Mass. 01966

27

This issue should be reaching your mailbox about one month before the 50th Reunion — June 6 to

June 9 at the Wianno Club in Osterville, June 9 and 10 in Cambridge. If you haven't yet signed up, but now find you can come, it's not too late. (And if you want to send in or increase your contribution to the Class Gift, it isn't too late for that, either.)

Bert Houghton phoned me in mid-March, from Medford, Ore.; he had just found that he can come, all the way from the West Coast. Unfortunately, his wife can't make it; she has a conflict of dates, and since one is in British Columbia, she can't fit them both in.

I've heard from a few others who were not on the original list but are hoping to come. **Jacob Muskin** is one; he is now fully retired from Singmaster & Breyer and writes that he is living quietly and comfortably in Hewlett, Long Island. **Fermo Blanchi** is another; he is in Framingham, and it is a short step for him.

Walter Walker is another addition to the list. Walter is a radio ham (in Newport News, Va. — W4AKN) and he writes that he has been in correspondence with Chuck Pope, another radio ham (K-6KF in California) who had previously indicated that he and his wife expected to come East for the reunion.

Bob de Luccia must be one of the busiest members of the class. Following his retirement as Senior Vice President of Pacific Power & Light, he became President of the Oregon Graduate Center for Study and Research (Master and Ph. D. programs only; no undergraduates). He then did consulting work in Vietnam, and is now Vice President of Overseas Advisory Services, Inc., and working in Saudi Arabia and Iran. He makes several trips to the Near East each year; he left in January for a month's stay.

George Cunningham won five ocean-racing trophies in 1976 in his Cal 25 (Lapworth design), sailing out of the Dana Point Yacht Club in Santa Clara, Calif.

George Bergman had been looking forward to the reunion, but he writes me that he has, unfortunately, had to cancel his plans because his wife is unable to travel following a stroke last year. George writes: "Know you will all have a hell of a good time, and just give my best to the whole gang." . . . Quite probably the longest trip to the 50th will be by Avedis (Casey) Kazazian, who wrote to me in March from Antofogasta, Chile, that he definitely expects to be here. With the political upheaval in Chile, he has been out of the country for the past four years, in Lebanon and Iran, and when he wrote in March his wife was still in Tehran. He has a daughter who lives in Tehran, and another in Upper Darby, Penn.

George Darling received an L.L.D. from the University of Michigan in 1975 — presumably an honorary one. George was director of the joint Japanese-American Atomic Bomb Casualty Commission for the National Academy of Sciences for over 15 years, ending in January, 1975. The Commission studied the effects of the bomb in Hiroshima and Nagasaki. In 1973-74 he was scholar-in-residence of the John E. Fogarty International Center for advanced study in health sciences. He is Professor Emeritus of Human Ecology of Yale.

Charlie Hurkamp, who has been retired since 1971, is working part-time on development of a patented shipping container, collapsible for return shipment. Most of his leisure time, at his home on Hilton Head Island, is devoted to golf. ... Walter Burger has no part-time working activity (he retired in 1969) but he notes that he keeps so busy that he can't even find time to read a book. He travels for six weeks each year, and the rest of the time attends many lectures, meetings, exhibitions, and the theater, plus entertaining and being entertained. ... Jim Flagg says he is enjoying good health in his retirement.

The new Cecil H. and Ida M. Green Hospital at the Scripps Clinic Medical Institution in San Diego is named after its principal contributor, who is M.I.T. 1923. The building, designed by **Edward Durrell Stone**, who is affiliated with our class, is reported to be typical of Stone's style, but "with some classical influence."

With some clippings from Ned Anderson is a note that he is treasurer of several local organiza-

tions in Westwood, Mass. He spends summers at his summer cottage on Lake Winnepesaukee, and also finds time for a little traveling.

Hank Kurt sends me some distressing news of Erik Hofman, who had been living on the island of Mallorca since his retirement from Standard Oil 12 years ago. Erik has become a victim of Parkinson's Disease, and his sister has brought him back to the United States. (Erik lost his wife four years ago.) He is now at Reservoir Nursing Home, Trapelo Rd., Waltham, Mass. 02154, and is holding his own. He would be delighted to hear from his friends.

I have two deaths to report this month. John T. McGillicuddy, retired President and Chairman of National Casket Co., died on February 5 at his home in Centerville, Mass. John had attended Harvard before coming to M.I.T., and subsequently took degrees from Holy Cross and the Harvard Business School; he also had an honorary degree from Suffolk University. He had been President of the Board of Governors of the Harvard Business School Assn. of Boston, President of the Casket Mfrs. Assn. of America, and a member of numerous clubs. He had been appointed a member of the Purple Knights in honor of his service to Holy Cross. There are no survivors.

Frank Rhinehart died in January, in Cleveland, where he had been an architect from graduation until his retirement in 1971. He had designed such Cleveland landmarks as the Main Library, Federal Reserve Bank, and Severance Hall. Among his other buildings were the Highland View Hospital, St. Christopher Catholic Church, and St. Ann's Catholic Church. He was a member of the American Institute of Architects, Ohio Society of Architects, and several clubs. I have expressed the sorrow of his class to his wife, Frances (Barrett). — Joseph H. Melhado, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

28

Your secretary and Florence have just returned from a two-week stay with Ted and Sarah Jope in Northfield, Ill., where they assisted in getting Adrian William Jope started on his journey through life. Adrian, born on February 22 (a date already famous) is the first grandson to carry on the family name of our deceased class president, **Ralph Jope**.

We have some brief news notes via the Alumni

Fund envelope route: Dave Haynes says he is glad to have his lobster boat safely stowed in his Maine boat house while he is enjoying a winter in Florida. . . Meanwhile Jim Tully is enjoying his retirement in Maine with skiing and by visiting with old M.I.T. friends. . . Dean Batchelder reports that wife Ellen has lost much of her sight since May, 1975. This now necessitates frequent trips to her eye doctor in Los Angeles. Dean's farm activities have been much curtailed. He still has occasional engineering design work on electric drives for oil wells. . . Alexander Daytz promises to write us later relative to his many activities.

Like many others, **Harlan Paige** took advantage of the "'77 Challenge" matching gift offer to increase his contribution to the Alumni Fund and Class Gift. In connection with this he had some correspondence with **Jim Donovan**. However, nary a word concerning himself. How about it Harlan? . . . Also writing to Jim, **Bill Hurst** continues his report on the lecture courses he gave in New Orleans last December. These discourses in the field of petroleum engineering were well received and brought him much favorable comment. Bill emphasizes the point that some 3,000 old wells in East Texas fields are still capable of producing oil. Needed is a properly coordinated effort and the application of modern techniques.

Clara and Arch Archibald make periodic visits to Boston so Clara can check in at her clinic. In addition they seem to do a fair amount of other traveling. During the recent year-end holidays they were in Australia. Because of the problems of distance they did not send out greeting cards. For this they offer regrets to their friends... Velma and Charlie Worthen journeyed to Florida to

avoid winter snows only to run into a snow storm in Sarasota. . . . Anne and **George Palo** made their usual trip to England last year and this time included a swing to Northen Scotland. George says he cannot write to us now without our reunion being uppermost in his mind.

Ruth and **Abe Woolf** are active with the American Association for Technion (technical institute in Israel). An outstanding event sponsored by this group was a concert by the M.I.T. Symphony Orchestra. This was held in historic Faneuil Hall, Boston, on March 15 with the prominent Israeli conductor, Dalia Atlas, on the podium. Your secretary and Florence were the happy guests of the Woolfs on this delightful and memorable occasion.

We deeply regret to report that **Terry Hurlbut** died on January 18, 1977. Terry's wife, Esther, wrote that he had been with the Veterens Administration since 1950 (following there years with the Navy Dept.). He retired in 1965 and they then traveled extensively until his health began to fail. To Esther and sons Terry, Jr., and Richard we extend our heartfelt sympathy. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

#### 29

Salvador Madero and his wife Esperanzo send greetings and best wishes from Mexico to all their friends. . . . Richard T. Hoffman has been retired from U.S. government service since 1975 with 42 years of service credit. "Most of the work I did," he continues, "was harder than what we did at E.E. Lab almost 50 years ago under Professor Lansil. That was in the early days of oscillating quartz crystals, some of which I ground from discarded eveglasses in the Mining Engineering Lab. I have a mentally alert wife, and children who take after her. Sally (daughter) is about to get her Ph.D. in astrophysics and she is an assistant professor in physics. Dick is the assistant traffic engineer for the city of Memphis. He got his degree from the University of Vermont.'

William F. Jenkins writes, "Thanks for the birthday card. I have now reached three-score and ten and still counting. On this occasion, I wrote a jingle, which goes, 'Now I have reached three-score and ten. That's one of my very best tricks, so here I go to do it again, I'll see two-ofour-six!' Wanna bet! When I retired, we moved to our place in the country where I am continuing my 'trees from seeds' hobby. I should have about 3,000 new seedling trees to give away next spring. My wife has quite a garden and we have been after ten various critters who feed in it. So far we have trapped four possums, one squireel, one black bird, our cat and neighbor's cat twice. We are now killing gophers using the exhaust from the truck. Never a dull moment!"... Warren Walker is still very active in his metal graphite business which is his pride and joy. He accepts every new challenge with a gusto. His work with the American Association of Industrial Management has eased a little since he has employed a retired Air Force general to be manager. However, Warren still composes and edits two monthly newsletters for the Association membership dealing with current economic and management topics. Warren and his wife Elise had a good holiday in June at the Cloisters in Lea Island, missing Jimmy Carter by only a few hours. Warren A. Spofford writes, "In September, I had a most interesting tour of the Soviet Union with a Texas Society of Professional Engineers' group, of which I am a director representing the East Texas chapter. I am also active locally with the American Association of Retired Persons and serve on the Tyler City planning commission as well." Warren has been retired since 1973 from General Electric.

Frances M. Hendershot (formerly Bonnar) writes, "Thanks for the birthday greetings. My former husband, Robert Bonnar, '27, died in 1974 and I am remarried to an old friend of 40 years. We have recently moved from White Plains, N.Y., to Heritage Village, Southbury, Conn. I am nonored to be considered part of your class, as I attended M.I.T. for only one semester."

I regret to announce the death of **Norman V. Ballou** of Dublin, N.H., on January 7 after a long illness. He was an executive, before his retirement, at the United Shoe Machinery Corp. of Boston for many years. He leaves his wife, Ellen, as the only survivor.

I received a letter from Hunter Rouse in reply to a note I had sent in regards to missing class news in the Review for a few issues, which reads, "Many thanks for your long, newsy letter. Your record of consistant publication of the 1929 column was so long that we surely cannot hold a momentary lapse against you. But don't make a habit of it, with our 50th approaching so fast." The lowa Institute of Hydraulic Research announces with considerable pride the publication of Hunter's seventh book entitled History of Hydraulics, completed in his 70th year. During a long and active life, he has participated in five of the 20 decades of accomplishments that are covered by the book's title, including what he has called "Hydraulics' Latest Golden Age." Last year his manuscript received the first John R. Freeman Prize awarded by the Boston Society of Civil Engineers. The Hunters have now settled permanently in Sun City, Ariz., leaving lowa City but retaining its rich memories.

Herbert L. Alley writes, "I sold my Key Haven Motel in Tavernier, Fla., and built myself a new home on the same Waterfront where I have lived since 1947. I was a member of Upper Keys Kiwanis club for 23 years and president in 1972. I also retired as Director of four southeastern states' National Wildlife Federations. I was in Somerville, Mass., in March and in April, and I attended my 50th Class Reunion at Purdue. I see our M.I.T. 50th Class Reunion is slowly creeping up on us. I will try to make it. Last week, I had a major surgery at Doctor's Hospital at Coral Gables and I am recovering from it. My best to all Alpha Theta Omega members, wherever they are." . . . Thomas W. McCue writes, I am still in sales, national and international on a commission basis. I am also taking management and accounting courses at Boston College. I had a slight accident at the MBTA subway which interfered with my attendance at my courses. Best wishes to all."... Laurence L. Waite writes "Now ... Laurence L. Waite writes, "Now that I am pushing 70, I see myself gradually slowing down. I can no longer pick up a 100-pound weight as easily as I did two years ago. I see other changes too, which come with the process of growing old. I lead a quiet leisurely retired life, which is getting a little dull. My best regards to

Vincent F. (Jerry) Gardner writes, "I am still at the Massachusetts General Hospital, running and overseeing three major projects, thus, enjoying my 'retirement.' I visited and spent some time with John G. Sullivan in Dennis, Mass., while vacationing there last summer. When are we going to have another 50th Reunion Committee Meeting? I am happy that we are going to Chatham Bars Inn once again."

In the January issue of the Review, I made an error and listed Alexis B. Kononoff as belonging to the Kiwanis. I received a letter as follows: "When I received the January Review this morning, I turned to the '29 class notes as usual and I got sort of a mild shock! Kiwanis is a great organization, some of my best friends belong to it, but I am a died-in-the-wool Rotarian, belonging to the Rotary Club of Hialea-Miami Springs Chapter. I have just celebrated my 70th birthday, and I receive monthly Social Security benefits which are most welcome. Since I am permitted to have supplemental earnings, I have recently incorporated my business, Alexis B. Kononoff, Consulting Engineers, Inc. I use this company as a vehicle for carrying out various consulting work in which I am engaged from time to time. When and if any of our classmates happen to be in or around Greater. Miami area, I would love to have them drop me a line or call for a get-together and talk about 'old times.' Address: 380 E. 35th St., Apt. 12, Hialea, Fla. 33013; 305-888-9576."

A Christmas note from **Edward C. Roche** reads, "Hope and trust the year has been good to you and yours, as it has been good to us. The ski areas to the south of Buffalo have been doing a

'land office business' with an early snow fall and cold weather for the past several weeks — most unusual for this time of year; before the advent of winter. How is the weather around Hampton, N.H.?" I am sure Ed has more to report about "snow in Buffalo" after what came to pass this winter in that region!

In retirement, Carl W. Harris is tutoring grade school children in arithmetic. He also plays chess with rest home residents. For recreation, he plays tennis and swims a lot. . . . Murry M. Brimberg and his wife Mary have just returned in December from an exciting and stimulating trip to Israel where they joined 3,000 other visitors from the U.S. to pay tribute to a small democracy, in their spectacular courage and rescue of their citizens from the clutches of terrorists. . . . John R. Clark is continuing his semi-active status in business. being an executive consultant to the U.S.A.F. Scientific Advisory Board. He is also maintaining his contacts with M.I.T. affairs in the Industrial Liason Program, Alumni Day, Technology Seminars and Dallas Alumni Club.

Howard S. Pankratz writes, "For the past two months, October and November, my wife Margaret has been suffering from phlebitis in both legs. She is trying to delay major surgery with its pains and confinements. As for myself, I have made three trips to Peking and Shanghai, Peoples Republic of China in the last 12 months. Two of the trips were paid for by the Chinese government for consultation work. It is a sad commentary that a 72-year-old engineer is grounded in the U.S., while a much poorer country, China, seeks out my services. Our oldest granddaughter, Brenwen Crothers of Lexington, Mass., spent a week with us last June, then went to the American Conservatory Theater, San Francisco, for nine weeks. You might have seen her in 'Taming of the Shrew."

Rolf A. Zurwelle writes, "My dear wife passed away five years ago. At that time, I left Long Island and my business and moved to Churchville, Md., and reestablished my business there — industrial design and product working in all fields, including static electricity and solar energy. Your kind birthday card reminded me that I am 70-years-old and by the grace of Almighty God, I am able to work in my business as well as work at a 30-acre farm we rent. My present wife, Polly, is from a farm country and helps me to plant all kinds of vegetables and food crops." — Karnig S. Dinjian, Secretary, 10 Ancient H'way at Plaice Cove, Hampton, N.H. 03842

### 30

Again this year and for reasons that have never been entirely clear to me there has been a vernal freshet of news items — so many, in fact, that I have decided to horde a few for next month's issue. From those of you who have responded to my requests for information and do not find the results set forth below, I ask patience.

Mark Purcell, like quite a few of our class mates, is nominally but not really retired. Mark practiced architecture in Madison, Wisc., with the firm Siberz, Purcell and Cuthburt. He has now bought out his two former partners who "pooped out before I did" and is in sole possession of the firm's records but with "none of the red tape, no payrolls to be met." He is in touch with many former clients, some of whom continue to come to him with their building projects. However, the work load is such that he can set his own pace (a methodically slow one) and has time for "selective travel, theater, music, reading, and writing."

Fred Turnbull reports tersely that he is still practicing patent law in Washington, D. C. . . . Joe Kanla is still taking annual trips with the Vancouver Board of Trade Mission. By the time these notes appear, he will have completed a trade and goodwill mission to Hong Kong, Singapore, Korea, and Japan. At last report he had taken more than 25,000 color photographs during the course of these trips. . . . Juel Lensch retired two years ago from his job as a branch chief of the South Pacific Division of the Corps of Engineers. According to my records Juel is still living in

Orinda, Calif.

Charles Lyle has retired from his job as a mechanical engineer at the Aberdeen Proving Ground. He is "living on an old farm on the picturesque shores of the Susquehanna" in Havre De Grace, Md., and would like to hear from those who remember him.... Lester Meyer is still working for Sheppard, Morgan & Schwaab, Inc., civil engineers and surveyors, in Alton, III. He gave as a for-instance the fact that he had spent the "last four days setting reference points in an underground limestone mine." His prescription for M.I.T.'s future is that the Institute be kept "heading in the right direction, not 'too far out.

Henry (Hank) Halberg reports that he retired from his job as hydraulic engineer with the U.S. Geological Survey in Little Rock, Ark., in September, 1976. He and his wife plan to remain in Little Rock. According to my records Hank's principal hobby is bird watching. . . . Dick Phillips retired from A.T.&T. about four years ago. As previously reported, he and Evelyn live in Old Greenwich, Conn., and do considerable traveling. Also, they spend a great deal of time at Moosehead Lake in Maine. In between times Dick enjoys gardening, much golf and a little tennis.

We have at hand notices concerning the deaths

of two more of our classmates.

William Clifton McLendon died on December 1976, in Winter Park, Fla., where he and his wife Kathryn had lived after his retirement from his position as chemical engineer with the Consolidated Paper Co. in Wisconsin Rapids, Wisc. He is survived by his wife, three children, and four grandchildren. According to my records he was active in the University Club in Winter Park which includes some 20 M.I.T. alumni among its members

Everett C. L. Kroehler died in Naperville, III., on December 31, 1976. Everett and his wife Fern lived in Naperville, III. He served in the Inspector General's Department of the U.S.A.F. during World War II and was associated with Kroehler Manufacturing Co. for more than 30 years. Gordon K. Lister, Secretary, 530 Fifth Ave., New York, N. Y. 10036

It was with considerable sorrow that I learned of the death of John P. Elting. John was a fraternity brother of mine and I knew him well. While working for his Ph.D. at M.I.T., his eyes went bad on him and according to newspaper reports, he was legally blind. He overcame his vision problems to become a pioneer in the textile industry. It took special eyeglasses and lights, and blackboards but overcome his handicap, he did.

Warren T. Dickinson writes that he has retired from Douglas Aircraft Co. after many years. He still enjoys flying privately and says that he would like to see M.I.T. reduce its dependence on the federal government as much as possible. Continuing, Warren says that we are all losing our independence. . . . Joe Buswell is enjoying his second winter in Sun City - tennis, chess, swimming, round dancing and hiking. He lives in a 27-ft. travel trailer near Kingston, Wash., from May 1 through September and his address is 20346 Marine View Dr., N. E., in case any of our classmates get out that way in the summer. . . . Alexander H. Kuhnel has retired. . . . Col. Harry D. Kamy says his activities are many and varied. He was relieved from the military in 1964 but continued working in civilian research and developement until 1971. Now he is fully retired and spends his time traveling, with Masonic activities and puttering around the house. . . . Charlie Seaver writes, "My only schedule in '73 [?] was three workouts at the Y.M.C.A. each week. Hence, have enjoyed skiing, gardening and sailing my 470 frequently." Charlie also, "has attended several seminars on vibration control while hunting for a niche in my retirement career.

I enjoyed the M.I.T. Fiesta in Orlando in February . . . but wish that the Committee could arrange someway for classmates to be seated together. There were a few other '31ers there . but the only one I ran into was Al Sims and then



Naomi and Daniel Johnson, '31, of Melrose, Mass.

we had only a few minutes to chat. I believe that Al lives in Florida during the winter in a trailer and at his home in Rhode Island for the summer.

At least three members of the class attended the Alumni Council meeting in February: Howard Richardson, Ed Hubbard, and John Swanton.

A newsclipping from the Alumni Association tells of Lewis G. Eaton's death on December 27, 1976. Lewis joined the New England Electric System in 1934 and served as a lieutenant colonel in the Army Signal Corps. He was also a member of the National Academy of Science, National Academy of Engineering and the National Research Council's evaluation panel for the Bureau of Standards. Our deepest sympathy to his family. Edwin S. Worden, Secretary, P.O. Box 1241, Mount Dora., Fla. 32757; Ben W. Steverman, Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216; John R. Swanton, Assistant Secretary, 27 George St., Newton, Mass. 02158

The 45th Reunion Committee anticipates a good turnout for our June meeting and has prepared a very interesting program. Hope to see you there!

My mailbag has been unusually active these past few weeks. Jim Abbott reports since retiring from the Gillette Company in November, 1976, he is residing full time in New London, N.H., where the latchkey is out for M.I.T. travelers passing through. Jim assures me that it is beautiful country up there and from his secluded spot the views of Kearsarge, Belknap, and Ragged Mountains are spectacular. . . . Calvin H. Mohr of the class of 1933 furnished me the following news: Tom Weston will not retire until his son, now a sophmore in high school, is launched in the world. Tom has a married daughter who is a college student and a single daughter in her junior year of college. His oldest boy is in the restaurant business. Tom and his wife have been most active in church work and were honored for their 25 years of work with Pilgrim Fellowship. Cal also informed me that James Shackelford had retired, but had no further details, and that Al Stewart is president of the Fall River, Mass., M.I.T. Club.

Jim Harper talked with Johnny Lawrence in San Antonio recently, where Johnny told him that class news in that area was quite scarce since our class representation was very limited. Jim also had a pleasant chat with Major General Ralph M. Osborne, U.S. Army-Retired, who joined our class after graduating from West Point. As an ordnance officer, he gained his S.B. in 1932 in Mechanical Engineering and took his first assignment at the Watertown Arsenal. In the early 1960s he was the U.S. Army Commandant in Berlin, and served the last year and a half of his Army career at Fort Sam Houston. Since retirement he has been very active in San Antonio civic affairs. General Osborne and his wife have grandchildren in Tennessee and Kentucky.

Carl J.H. Wahlstrom furnishes the sad news that Carl A. McKinney passed away in Houston, Tex., on February 26, 1977. The Wahlstroms had a pleasant cruise to Alaska last July out of San Francisco, the highlight of which was Glacier National Park without fog. Carl reports that he and his wife are in good health with no complaints except inflation. . . . Dr. George B. Hoadley and his wife have spent a very busy 1976 traveling. Starting in February with a trip by ship from Manzanillo, Mexico thru the Panama Canal, around South America thru the Strait of Magellan to Chile and Peru; then to Cusco, Machu Picchu and Bogota. During the summer they went to Germany followed by a trip on the St. Lawrence and Erie Canal. In the fall they took a trip to the Orient, and closed out the season with a cruise to the Caribbean. That should certainly establish some sort of class traveling record.... Bob Prescott and his wife are enjoying the warm climate of Arizona as permanent residents. Occasional consulting visits to the East make the Arizona climate more appre-

Guy C. Lentini retired from teaching in the Boston Public Schools in 1975.... George H. Sistare, Jr. retired in 1974 but still remains active with consulting work in the precious metals field. For relaxation he does a bit of cabinet-making and fiberglass boat repairing. . . . Dr. Samuel E. Paul is working as a psychiatrist for the Fresno County Mental Health Department and also doing some teaching for the University of California at San Francisco School of Medicine which has affiliation with the Valley Medical Center at Fresno.

... Herbert H. Uhlig, Visiting Scientist at Woods Hole Oceanographic Institute and Professor of Metallurgy Emeritus at M.I.T. is on the faculty at the Northeastern University Center for Continuing Education in its course for Corrosion Engineering and Materials Selection.

In addition to the above-noted passing of Carl McKinney it is my sad duty to inform you of the sudden death of Arthur Lowery on January 15, 1977. Arthur was an officer of the Alumni Association for many years and his election to the Alumni Council was indicative of the respect and esteem of all who knew him and his dedication to the Institute. The sympathy of the Class is extended to Mrs. McKinney and Mrs. Lowery and their respective families. - John W. Flatley, Secretary, Apt. 204 - 5100 Dorset Ave., Chevy Chase, Md. 20015

Banner headlines this time around must be awarded to four of our classmates who were honored by their Alma Mater. In December, the M.I.T. Corporation awarded Gordon Bunshaft, Ivan Getting, Ralph Cross, and Ralph Hayden, Jr. with the Institute's Corporate Leadership Award. Jim Turner and Ellis Littmann attended the meeting as members of the Corporation, and Dayton Clewell, George Henning, and George Vila attended as invited guests. The Awards included a Silver Bowl, suitably inscribed. For our entire class, please allow me to congratulate our four so suitably recognized. It seems appropriate to note, here, that Dayton Clewell retired from Mobiloil as of March 1, 1977, after 39 years with Mobiloil. Dayt, your classmates join me in wishing you all that is good in your well-earned retirement. In his letter to me, Ellis Littmann included mention of another award to one of our most famous classmates, Morris Cohen. Morris was given the 1976 William Proctor Award of the Scientific Research Society of North America, which recognized Morris' achievements in scientific research. This coveted prize was given to Morris at the Society's meeting at Hershey, Penn. Again, Morris, we are proud of you, as we bask in your reflected glory. I do hope, personally, that you do not try to pile all your awards and prizes in one pile. It might become unwieldy.

We have four letters from Cal Mohr since our last writing, mostly requests for addresses for him to use in writing to his old friends. I predict that Cal's efforts will bear fruit, and more class news. Many thanks, Cal, and we all wish you luck. The newspapers can't possibly carry the picture that Cal tells about the cold, the snow, ice, thawing, and floods in and around the Ohio River, at East Liverpool, Ohio.

Although Don Fink's story appeared in the last issue of the Review, it did not call attention to his "unpaid" retirement at the end of 1976. His retirement is in name only, as he still retains an office in the George Bailey Room of the I.E.E.E. headquarters. Don is most active in the Academies of Science and Engineering in Washington. He is also executive consultant for the I.E.E.E. I choose to call it an honor that Don has been made a Life Director Emeritus of I.E.E.E... We have a fine note from Herb Grier, direct from Las Vegas. Herb has retired from EG&G, and is established in a consulting business, which is becoming more and more popular with retirees. (Gee, if I knew enough I might try that myself. As a matter of fact, I am a consultant - in the pure-bred cattle business. But, I abhor getting too much business.) As 1933 Class Agent since last fall, Herb is the Alumni Fund man, so you all can make him real happy by being a bit more generous as time goes on. Thanks for the message, Herb, and good luck.

Well, here is one from one of our live wires, Bill Baur. He is Secretary-Treasurer of the Central Florida M.I.T. Club, and works at it. President Wiesner was the featured speaker at their February meeting. Bill says that the committee made a personal visit to all members who lived in and around the Tampa Bay area, and there are many.

We have a fine pair of letters from Christine and Emmy Norris. You will recall that, about two years ago, Emmy suffered a massive stroke, which was pretty much 100 per cent. He had professional therapy at a county facility, highly recommended by Christine at the time. Since then Emmy has made a remarkable come-back, which suggests fortitude of magnificent proportions. Now, Emmy wrote me a letter himself, at which I was amazed, not by its content, but by the obvious will power it took to get the writing done, and readable. In his note, Emmy mentioned the passing of Bob Burton, who lived almost next door to the Norris'. A bit more will appear at the proper end of this tome. I think that we all ought to admire the great job that Emmy has done for himself. Any of his old friends may have his address from me if they wish to write him. Many thanks, Christine and Em.

We have a fine note from **Chuck Fulkerson**, who tells us that they spent a month in 1975 touring Florida — and that they had a fine Christmas at home, with three of their children with them. Elizabeth and Chuck belong to the Connecticut Valley Mycological Society (mushroom culture and study, plus separating the eaters and the non-eaters). Chuck also keeps a few hives of bees.

Neil Hopkins writes from York, Penn., about his family. You must recall that Ruth suffers from the rare, arrested form of Parkinson's disease, confined to her wheel-chair. But she was able to go to Plymouth, Maine, with Hoppy to attend a three-day Bicentennial celebration; further, they both will go to Plymouth, Mass., to attend brother Errol's 50th wedding anniversary. Hop is still greatly active in the York Symphony Chorus, a dedicated group who really work at fine music. Ellery Clark dropped in on them late in the fall, and from that visit we learn that Walter Galazzi has retired as Chief Engineer of the York Division of Borg Warner.

Now for a few Alumni Fund capsules. John Rumsey writes that he was fascinated by the animals, flowers, trees, and birds on their recent trip to Kenya, Tanzania, and Zanzibar; by mutual agreement he is now one-half retired. . . Still with the Massachusetts Department of Public Works, after 43 years, says Elmer O. Waterman, civil engineer. . . Imagine this guy: "Wife and I just returned from a two-month trip on a Yugoslav freighter in the Mediterranean, visiting ten ports, and had a great time," signed Prentiss Lobdell, now back on Longboat Key.

Russell J. Brooks, Atlanta, regrets that upon his retirement he must cut down his usual contribution to the Alumni Fund because of too small an income, plus inflation... Walt Swanton greets us with his interesting retirement story: has been a consultant for his former employer, Faudler Corp., and the Army Missile Command. Also he has served as professor at the Munroe Community College; and he's moved away from the village to an "idyllic" country home on the

banks of the Genessee River (Rochester).... Warren Webster puts in a lot of time tutoring youngsters in and around Boston; most of the kids have no money, so he does not charge them at all, a labor of love.

I have a newsclip entitled, "A government takeover of R & D," written by our own Dick Morse, who is President of the M.I.T. Development Foundation and Senior Lecturer at Sloan School. With our space, we cannot even try to summarize, as the article is real meaty. However, it seems to revolve around 1) Shall research and develop ment be carried on by industry with major support from the government, or 2) shall the government take it all over, with major support from and through industry? It appears that Dick favors the latter, under an independent federal agency, nonpolitical and of a permanent nature. Anyone wishing a Xerox of this fine article has only to write me, and he shall have it. Good work, Dick. We need fellas like you. . . . Cal Mohr sends us a letter he got from Bob Dillon, Bob is retired as of February 1, 1976, and is busier than ever: 'Twas ever thus, no? He has little time for house repairs, et al. as he has been elected to Treasurer of the Houston Section of A.S.Q.C., a rather active group. Also, he has been appointed to the Planning Commission of his home town, LaMarque, Tex. The Dillons spent last June at their camp in the Adirondacks, went west in September, and back to camp to close up in October. Bob and Alice find time to return to college taking credit courses with student competition, and it is no cinch. Plans now call for an addition to the Dillon house, very soon, and they also plan a trip to the Mediterranean and the near East, come June. A Dillon daughter lives in the country near Santa Fe. A Christmas card to the Dillons from Elennor Glenn tells that Roland is quite happy in retirement, and very busy at his consulting job in Connecticut. (The Glenns have lived in that area for some time.) We are indebted to Cal Mohr for this fine story of the Bob Dillons.

Bill Sheppard is a busy chap! He is Chairman of the Manasota Chapter of SCORE (retired executives) for 1977. He is also bookkeeper and treasurer of the Manastee Players, an amateur group in Bradenton, and, historian for the Southwest Florida Chapter of M.I.T. Alumni. Golly!! . . . Bill Pleasants works for Sussex County, Del., as Director of Coastal Sussex Water Quality Program; funded by E.P.A., Federal Water Pollution Control Act. . . . Beau Whitton comes through with a fine capsule; his retirement is practically complete. He and Daphne just returned from a tour of exploration into Ohio and Michigan, visiting kinfolk of both. . . . Ed Simpson says that he is State Director of A.A.R.P.; you could look it up, as you will surely be one soon. . . . Golly, here's one to notice; Leighton Rickards, formerly of the Space Center or near, Fla., writes from California, whence he moved several years ago. He is now with the Navy's Facilities Engineering Command, West, after doing some consulting. A son is a second-year law student; two older daughters are married, and there now totals four grandchildren: not bad, Gramp! The youngest daughter is in her senior year at B.Y.U. Thanks, Bro Rick.

Again, Charles Keller pops up, and I still do not know if he is the Keller I once knew. Mebbe he will write soon. He is Chairman of the Board of Trustees of Fauberg St. Mary Corp. of New Orleans, an organization dedicated to the restoration of historic buildings in the central business district. . . Now, folks, I have a personal item for consideration; we had a Christmas card from, "Joe and Margaret," with no possible way of our identifying the sender. Margaret also wrote a mighty nice message, which announced their first grandchild. Anyone willing to admit that he or she wrote and sent the card?

We have notice of two of ours who have passed on to their reward; **Robert Burton**, Course VI, passed away, midwinter at his home in Newcastle, N.H. He was a neighbor of the Emersons (above). Bob was a long-time employee on the staff at the Portsmouth Naval Shipyard. We have no other details. The other classmate who has passed on is Vice Admiral **Richard W. Ruble**, who took a master's degree at the time we took our bachelor's. Perhaps unnecessarily, I believe that I

must mention that several of our readers have asked about the blank spaces in the February Review, when many know that the notes as submitted, are edited, and at times, deeply. This is a mention, no comment required or intended. This is only as asked. Your secretary is not in the habit of passing on gripes, or favorable comments from classmates. We are not here for that purpose. I ask here, that all such should be addressed to the Editor or the Publisher.

That's it for May, folks. When you read this the snow and ice will be a memory only. — Warren J. Henderson, Secretary, Fort Rock Farm, Drawer H, Exeter, N. H. 03833

34

We are all familiar with classmates whose careers followed closely on the field they had studied and with others who made switches or adaptations as they went along. But considering the fairly specialized start, one of the most interesting changes I have seen was in a write-up on the activities of Arthur L. Grout, chairman of the Engineering Graphics Department of the Bridgeport Engineering Institute. He was recently awarded the honorary degree of "Fellow of the Institute," an honor that came after more than 31 years as a faculty member and administrator. What intrigued me was that Mr. Grout received both B.S. and M.S. in architecture at M.I.T. and then went on, not only to the teaching field, but also to a career in the aircraft industry. He has recently retired from Sikorsky aircraft after working there 25 years. Mr. Grout still teaches a course there in aircraft layout and lines development, continues his teaching at B.E.I. and is connected with Trio Industries in Shelton, Conn.

The rest of my news is from Alumni Fund notes, some held over from last month. Ralph Brown writes, "Ann and I are continuing our work on our old house here on the Cape with the start of a small garden and the planting of trees for espaliers. Spent an enjoyable six weeks in Switzerland this past summer, saw our son Ralph, '71, in Wuppertal, Germany, on our way. Great trip!" I might add that more recently they took a trip to Peru which was not quite so successful as they had problems at the high altitudes. . . . Still hard at it is Dr. George Gahm who notes, "I have been elected to Fellowship in the American Psychiatric Association. Have sold my Cessna 182 and have progressed to a Bonanza (faster - 200 mph). Am semi-retired, working only 50 hours a week!"

Albert Schulerud says, "Part-time consulting on soap process technology. Like other healthy retirees — playing golf, bowling, singing (solo and group) and traveling — Caribbean in January, 1976 and Hawaii in May of that year." . . . From the West Coast George Hatch writes, "My wife and I are in very good health. I retired from my architectural practice in October, giving time to travel, garden (orchids), read and putter. There are no plans of moving from our present home nor of curtailing non-business-related activities. I hope to see architect friends at the 1977 A.I.A. convention in San Diego."

Among the new notes received are two that are conspicuous by their brevity. From Howard Sharp "Management consultant" and from Theodore Steinberg - "President, American Association of Opthalmology." Well, I'm grateful for even that, especially since it means they have contributed to the Alumni Fund.... On the lengthier side, Russell Hastings says, "Although still Advance Engineering Manager for the Industrial Truck Division of Clark Equipment Co., I now find practically all my spare time plus a generous amount of company time being devoted to metrication, in as much as I am chairman of the Metric Practice Committee of the of the American National Metric Council. Would be glad to hear from any classmate on this subject."

Richard Shaw notes, "Retired. Helped with archeological dig in Shepaug Valley (Conn.) last summer. Very interesting."... Carl Wilson comments, "Retiring February 1 after 20 years at Foster Grant. No great plans other than an extended Florida vacation followed by a bareboat



We're not fooling... Bernard Whitman, '34, and the original master of magic, Fu Ling, are one and the same. At right, he performs with his assistant, a student at South Weymouth High School.



#### **A Master of Transformations**

"The things that bind us are merely phantoms of illusion." . . . So Fu Ling, the Mandarin Master of Magic, explains his transfer into a sack inside a locked trunk, surrounded by a laced canvas sack, where his assistant had been enclosed like a ball inside Chinese boxes only moments before. "All you need to say is gungi vitoi." The transformations of the unmasked Fu Ling, Bernard Whitman, "35, seem to be magic of this same order.

Mr. Whitman has been a lover of the magical arts since he saw a performance of the Great Thurston as a child: he had been a Tech Trickster while studying for a degree in aeronautics at M.I.T., and in 1955 he and his wife, Jeri, a principal performer in the magical theater, took their show on the road for ten years. But he wears many other guises as well.

The arts of illusion have now become a sideline to Mr. Whitman's new vocation. He began with the modest aim of teaching — to relieve himself of the labors of setting up the 2,500 pounds of stage equipment and sets for his show — but his innovative ideas propelled him to become administrator of the entire industrial arts program for the community of Weymouth, Mass.

It was a ready-made situation. "Industrial arts was still manual arts when I came to it," explains Mr. Whitman, "and it had even degenerated from that. Shops were where they sent the boys who didn't get along in the regular subjects." The teacher who preceded him advised him it would be an easy job: "All I'd have to do was keep the kids quiet. I hadn't been there a week when I'd begun to change that."

Soon his students were producing the unheard-of: a one-man submarine, a minimotorcycle, a hovercraft, and an eight-inch Newtonian telescope. His is the first program in the country to have a research program on alternative energy forms — solar collectors are built and tested, and there is a windmill on the roof of South Weymouth

High School which generates the power to illuminate the school sign at night.

His background in industry gave him a new approach to teaching. (At Chance-Vought Aircraft he was Chief of the Experimental Department, and when his company merged with Sikorsky Aircraft, Mr. Whitman worked with Igor Sikorsky on the original helicopter. After World War II, Mr. Whitman returned to M.I.T. to become executive officer for the Guided Missile Program at Draper Laboratory.) He changed the name from shops to laboratories ("we're experimenting with industrial processes," he explained); and industrial arts was run as though it were a company. The students organized a corporation (with officers), developed prototypes of products, sold stock around the school, and later marketed their products - one of which is an wrought-iron coffee table which has found a home in Mr. Whitman's colonial Cape Cod House. "You've got to go to reality," he exclaimed, "you can't just simulate these

He wants students to leave his program with an idea of what it's like to work in industry. He uses the terms wages and compensation rather than grades. At the beginning of a term the student will draw up a contract with his teacher: what he'll do, how much will be completed, and what skills will be learned. There are renegotiation clauses if the work is delayed or materials don't arrive; penalty clauses for infractions on safety regulations. If the student fulfills his contract he will automatically get an A — after he meets his teacher at the conference table and justifies how he has done so.

"We're teaching not only saleable skills, but also saleable attitudes." And this is most important, explained Mr. Whitman, because industry is often willing to give further skill training.

This is just the tip of the entire program he's initiated in the Weymouth system, all the way down to the elementary level. And if this weren't enough to keep Mr. Whitman busy, somehow he can't seem to keep his magic show put away in the barn. It began when the Society of American Magicians asked him to revive his arts for their national conference in Boston in 1974.

Herman Hanson, Dean of the Society of American Magicians and the Great Thurston's understudy, had just died. As a tribute they asked Bernard Whitman to perform again Thurston's floating ball illusion, "When the Spirits Come Back" — a startling six-minute number which-took Mr. Whitman, the only magician in the world who has mastered it, a year to perfect when he first performed it in 1961 and three months to rehearse for this show. In 1961 he received the Gold Cup of the Society of American Magicians, the Society's highest award, for the finest professional performance.

A gasp went through the audience when he appeared on stage looking precisely like Thurston himself, whom many of the magicians had known personally. The illusion is capped when he guides a silver sphere from a cabinet to rest in suspension above his hand (he passes a hoop around it to prove it unattached, and a metallic sound reverberates as he taps it with a key), and then it drifts across the stage and out into the audience. The ovation he received encouraged him to promise a return performance - this time in the guise of Harry Kellar, the famed American illusionist at the turn of the century. At that performance he was assisted by students from South Weymouth High.

This was the beginning of the Weymouth South High Touring and Magic Co. By the end of this season they will have raised \$1,000 in scholarships and \$7,000 for other organizations. The opportunity for high school students to perform in front of strangers rather than on the home stage is an unusual one. Now Mr. Whitman has plans to begin a drama exchange between several area schools. It will become "a new dimension in drama education," said Mr. Whitman in his ever-enterprising way. — S. F.

charter in the British West Indies in April. Will continue to work on Public Relations and some technical committees for the Sunglass Association." After the winter temperatures we had in eastern Massachusetts I'm sure Carl will lap up both Florida and the sailing trip.... Irv Kusinitz still seems to be living out of suitcases. Witness the following: "This past year has been my wildest since I started traveling as Director of Engineering for Beatrice Chemical. After getting back from Mexico City and Rio de Janeiro in December, 1975, I have made three trips to Europe, another to Rio, and three more to Mexico City, one with my wife Rose. I think I'll keep it up a little longer, since things are still very interesting."

Frank Moore is still "working on the railroad," he writes, "as Resident Engineer on construction of a ten-mile-relocation of Western Maryland Railway. This sure beats designing computer junk and such trash!" All of you who may be working for IBM, Univac, Digital Equipment, etc., please —

no letter bombs or voodoo dolls.

There are more notes but I'll keep those for next time, lest the West Coast drought comes East. — Robert M. Franklin, Secretary, Satucket Rd., Brewster, Mass. 02631; George G. Bull, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, Md. 20015

35

It was good to receive a letter from Frank Hatch. who recalls playing in the '35 Golf Tournament last year and hopes to do so again this year. He writes, "Ham Dow and I have gotten together twice singe then, once at Stanford and once at his club, the Villages, in San Jose. If I am to do anything in next tourney, I'm going to have to improve, and I am working on that. Our younger daughter lives in Maryland not far from Washington, and last May I visited her, her husband, and our grandson. Her husband, who is in the Air Force, was made Air Force aide to the President last November, and that has changed their lives as you can imagine. We see him on TV once in a while when the President is in the news." Robert W. Barker, '21, dropped me a note with the news that Hal L. Bemis has been elected President of the Union League of Philadelphia. Our congratulations go to Hal and many thanks to Mr. Barker; it's this kind of assistance which warms a Class Secretary's heart.

Chi Phi's Beta News reports that Alfred E. MacAdam III, of Vero Beach, Fla., was appointed Councilman to Town Council of Indian River Shores, Florida, October, 1976.... Robert S. Duncan, who received his master's degree with us is celebrating his 40th year with Bell Laboratories. He has been at their Gulford Center, N.C. location since 1958.... Bob Forster passed along news that the following three have joined the retirees: Bob Kennedy of Armonk, N.Y., has left Union Carbide for Tucson; Dick Hughes of West Hartford, Conn., has retired from Hamilton-Standard; and Tom Keeling has gone to Hilton Head, S.C., from Pittsburgh Paint... Max Wasserman is taking an active part with the Council for the Arts at M.I.T. as part of the Leadership Campaign.

I have a substantial pile of news to pass along to you received through the Alumni Association: From Bob Olsen, "It was great to get back into a shell again after 40 years. We should plan on doing it again at the 45th and 50th (We will. — Ed.) Amy and I square dance a lot these days. I hiked the Loyalsock Trail last July - 57 miles - it felt great. Still teaching management (social) science (at Penn State) and enjoying it. Learning Spanish in preparation for retirement. Helped start a home for retarded children five years ago - it's going well. Enjoying life immensely and plan to enjoy retirement in 0-2 years." . . . From Lew Simon, "Entertained Selma and Leo Epstein in September at our new home in Leisure Village, 14120 Village 14, Camarillo, Calif., 93010."... From Philip H. Rhodes: "Still Technical Director and Manager of Custom Coated Products (Cincinnati), having the fun of trying to build a small company to a substantial profitmaker. So far real lucky in building both business and staff." . . . Nelson Thorpe writes, "Had a nice trip this Fall to Scandinavia, Austria, and Switzerland. We both continue in good health." . . . Theodore A. Earl writes, "Retired yacht broker - winters spent in Simsbury, Conn., summers at Winter Harbor, . From Richard L. Parli, "Have been Maine." living in Arlington, Va., for the past 30 years or more practicing both architecture and real estate appraising (the latter for only five years). Have two grown children - Lynn Modecki, whose husband is Executive Director of the Massachusetts Bar Association, and son Richard, who got his master's in business administration from Penn State and is working with me in the appraisal field. Bridge, golf, and gin are my hobbies, with the distance on the golf course getting a little longer every year. Both wife Virginia (from Arkansas - a tri-delt from Texas) and I in excellent health and looking forward to many more vears of activity." . . . John Alden writes, "I have been appointed Editor of monthly newsletter for Boston and Maine Railroad Historical Society, Inc. My collection of railway items is making a "mini-railroad museum" in our basement."...

David J. Buckwalter writes: "Last March I made that big decision to retire from the Ralph M. Parsons Co., and my wife's arthritic problems led us to return to dry Arizona. In August I was offered a half-time position in Tucson as representative and consultant for Davy-Powergas, Inc."... From Blake Mills, S.M. '35: "I have completed 30 years as a mechanical engineering professor at the University of Washington (my alma mater)."

I am sorry to have to report the deaths of three more of our classmates: Lewis H. Finneburgh, Jr., who died October 3, 1976; Ira L. Grishaver who died December 3, 1976; and Edward S. Prohaska who died December 13, 1976. On behalf of their Classmates I send our deepest sympathy to their families.

If you are a golfer, or like to play golf and haven't heard the details of the 17th Annual Class Golf Tournament, please contact me right away — we can always make room for more. We want to be sure we can give Bill Bates all the competition possible.

And please let me hear from you anyway. Do not forget that **Bernie Nelson** and **Ned Collins** are arranging another Mini-Reunion at the Faculty Club on June 10. We had a fine social evening last year; come and see old friends again. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

Increasing numbers of the class are retiring but even so many of us are still "making waves", or rain! Norman Copeland, Senior Vice President at duPont, has been named Fellow of the American Institute of Chemical Engineers. Dave MacAdam, a graduate member of the class, in his retirement has been appointed a part-time professor at the Institute of Optics at the University of Rochester.

Feature articles in newspapers which have come my way include one on Bernard Vonnegut who is referred to as "a celestial iceman" for his work in cloud seeding with silver iodide. At the State University of New York at Albany, Bernie is currently engaged in research on the relationship between clouds and electricity and on methods of measuring tornado speeds.... The second article from the Lynn (Mass.) Evening Item features Barney Rabin, who in the depths of the Depression started a modest business printing names on school diplomas and certificates! The enterprise has prospered and is now the fourth largest of its kind in the country. For nearly 30 years, the Barney Rabin Co. has been located in Marblehead.

Contributions to the Alumni Fund have brought other tidbits. Wilfred (Wiley) Post was honored by the Allentown/Lehigh County Chamber of Commerce with its Distinguished Service Award for "outstanding leadership in the fields of community service and professional achievement." He is manager of the Allentown-

Bethlehem-Easton Airport.... Leonard Chandler writes that after 37 years with duPont he retired the first of the year as Assistant to the Technical Director in the Textile Fibers Department. He anticipates pursuing his interests in viticulture and oenology (grape growing and wine making in case you wondered).

John Rowan retired in the fall of 1973 as a fulltime petroleum consultant in Montreal. He summers in Ontario and winters in Clearwater, Fla., and continues part-time consulting... Martin Gilman whose volunteer activities in retirement have been many and varied has now become president of the Lexington Historical Society... Ronald Beckman enjoys the fishing in Marathon, Fla., and occasional travel.

Graduate members of the class who have responded generously to the Alumni Fund matching gift program include **C. Donald Brown**, who writes: "Although I spent only one year at M.I.T., it's a pleasure to take advantage of the generosity of the individual graduate who has agreed to match the increase in my gift of last year." ... With his contribution **Merwin Miller** reports that he retired from Standard Oil of California last July. He was a Sloan Fellow. . . . **Arnold Kruse** retired in December after 40 years with the Hawaiian Commercial and Sugar Co. He is now self-employed as a consulting engineer for sugar factories.

As usual with their year-end letter, Ruth and Henry Lippitt report a busy, interesting year which included business and vacation trips to El Salvador, Mexico City, Switzerland, and Sweden and a family reunion in Rhode Island. In the times between, Hank works diligently for the California Natural Gas Producers Association

A note from Florence and **Mal Graves** from Lynchburg, Va., reports that Mal is assitant professor of Management at Central Virginia Community College. He devotes his spare time to the design and construction of a solar-energized home, where the Graves may be living by the time you read these notes. — **Alice H. Kimbali**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

37

Maurice Bell writes, "On June 28, 1976, I retired from my position of Associate Dean for Research and Professor of Geophysics in the College of Earth and Mineral Sciences, The Pennsylvania State University, after 20 years of service, with the title of Associate Dean and Professor Emeritus.' . Thomas Hennessy is a consultant architect and interior designer for the American Hotel and Motel Association. In private practice he does architecture and space planning for banks, facilities for the physically disabled, and facilities for the traveling public. . . . Jean R. Portelance is now retired from the City of Montreal Public Works Dept. and is moving to the Laurentians in a new home just purchased, where he will be able to do some gardening during the summer months. His wife, daughter and grandson will be with him. . . . Fred Altman has just written a paper on "Occurence of Intense Rainfall" which he has given in France. . . . Bob Cornforth has recently joined the H. K. Ferguson Co. in Houston as a Director of Marketing. . . . Dave Hill has moved to 3903 Durham Place, Flintridge, Calif. 91011.

Next month we will be attending our 40th reunion. From the response to our mailings, we should have a good attendance with a fine program of events. — Robert H. Thorson, Secretary, 506 Riverside Ave., Medford, Mass. 02155; Lester Klashman, Assistent Secretary, 198 Maple St., Malden, Mass. 02148

38

I had not realized how photogenic some of our classmates are until recently. A picture of Al Wilson, who was recently elected President of the Board of Trustees of Mt. Auburn Hospital, appeared in the Cambridge Chronicle. . . And we have a new television star. If any one of you saw a recent television ad for the Homelite Divi-



Al Wilson, '38

sion of Textron, you would have seen Frank Atwater. Chairman of the Division.

M.G. J. Boissevain writes that he is still at General Dynamics Electric Boat, responsible for selection, training, and evaluation of shipyard foremen. . . Eric W. Thrift informs us that he is a professor at Queens University, Kingston, Canada, in the School of Urban and Regional Planning

An invitation to any M.I.T. grads going through Seattle is extended from **Gus Rossano**, who is still going strong as Professor of Air Resources Engineering, University of Washington in Seattle. He has enjoyed traveling around the world on consulting assignments and has published five books to date.

I received notice of the recent demise of Theodore Timble, who was Senior Engineer in the Small Aircraft Engine Division of the General Electric Co. River Works in Lynn, Mass. — A.L. Bruneau, Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

### 39

Lead-off spot this month is for Burt Grosselfinger, '38, who graciously spent many hours during 1936 helping me with 5.01 and 8.01 homework and who accepted my tribute in the form of evening errands to bring him cider and milkshakes from the Tech Delicatessen. Burt wrote that **Bob Pastene**, who has been living in Minneapolis/St. Paul, appeared in the new "King Kong" and will be in a future episode of "Kojak." From *The New York Times* Burt enclosed a three-column theater review clipping showing Bob Pastene's picture. The reviewer paid high compliments to Bob who played the leading role in Ibsen's play "John Gabriel Borkman."

Bradley Bennett has retired from the Vice Presidency of Universities Research Association, which operates Fermilab for physicists in the high energy field. Bradley said a major achievement was to allow the lab director enough freedom (with cooperation of the A.E.C.) to enable him to bring the 200 GeV proton synchroton into operation ahead of schedule and under budget, and to operate it at 500 GeV, which is 250 per cent of specified design rate.

Jack Herlihy wrote: "Except for World War II service as Maintenance Engineering Officer on B-17s, I have worked since graduation for Inland Steel Co. in East Chicago, Ind. My present assignment is managing Industrial Engineering Services." . . One of our '39ers sent this note with his contribution to the Alumni Fund: "This is the amount paid to cover the costs of my freshman year".

Martin Lindenberg has been re-elected (second term) as President of the M.I.T. Club of New Bedford... F. Stanley Nowlan was recently honored by the American Institute of Aeronautics and Astronautics at a symposium conducted by eight national technical societies in Philadelphia. The award, consisting of a medal and certificate of citation, recognized his contributions in conceiving and developing the decision-tree oriented approach to aircraft maintenance program design.

Edmund Rittner has accepted assignment to the editorial board of the Journal of Energy, a new bi-monthly publication of the American Institute of Aeronautics and Astronautics. The Journal will report efforts in industries and disciplines where advanced theory and practice are applied, and also energy initiatives being undertaken by the

aerospace industry. Ed has served as Director of Applied Sciences for Comsat Laboratories, and his prior career work included supervising re search and development on tunnel diodes, violet and non-reflective solar cells, radiation damage, thermal coatings, batteries, and ion engines.

Francis Sargent was appointed to the Board of Overseers of Emerson College. . . Sid Silber wrote: "What started on a Tech Dinghy on the Charles River has developed to become a source of continuous pleasure for Jean and myself. We now enjoy our Alberg 30 on Chesapeake Bay and compete in the races."

On Saturday, July 9, Hilda and I expect to be with approximately 10,000 Barbershop singers in Philadelphia. Our 100-man San Diego Chorus is champion chorus of the five western states. On that Saturday afternoon we shall be competing against 14 other District Champion Choruses, and one of the choruses will earn the right to represent SPEBSQSA as its International Champion Chorus for the coming year. Come to the City of Brotherly Love, and listen, and join in some of our harmonies. — Hal Seykota, Secretary, 2561 Via Viesta, La Jolla, Calif. 92037

### 40

Letters from Home: M. Arnold Copeland writes from Allentown, Penn., "I am happily married to a Radcliffe Class of '43 gal (Naomi Sharenson) and we are the proud parents of four daughters!" His Copeland Construction Co. is building "industrial. commercial and institutional buildings such as banks, schools, hospitals, truck terminals, factories, etc. Some of my spare time is spent as Chairman of the Property Management Committee for the Girl Scouts Council covering a number of counties in eastern Pennsylvania. Having four girls I guess this could be expected. Right?" Arnold is national secretary of the Professional Engineers in Construction Division of the National Society of Professional Engineers, and is a member of the board of governors of the General Contractors Association of Pennsylvania. . . . Norman R. Klivans, who lives in Chagrin Falls, Ohio, writes while on vacation in Sarasota, Fla., for the winter: with a small Cleveland-based consultant group known as Western Reserve Associates . . which includes Fred Reuter, '38. "Alice and I are both fine. Recently we moved into exurbia and now live on a semirural road outside of Cleveland. Our older son, Norm, Jr., is at Stanford Business School and Charlie is an industrious social-work professional in Portland, Ore.'

Notes From Alumni Fund Envelopes: H. Garrett Wright in Springfield, Mo., says "I now have six grandchildren — all boys — for M.I.T. Last summer drove the ALCAN highway to Anchorage. I am completing my fourth year on the local City Council." . . . John C. Quady writes from La Jolla, Calif., to say he recently participated in the winning proposal for the design and construction of a 3,000-ton U.S. Navy ship by Rohr Marine, Inc. of San Diego, a six-year, \$ 300-million contract. . . . . Joseph Greenberg in Chicago says, "I have formed a group at A.J. Kearney, Inc., which will handle engineering services for foundries and steel plants . . . including . . . environmental control, OSHA control and energy conservation activities."

Music Man: Leonard W. Weaver, director of research at Bird & Son, Inc., doubles as music director of the Neponset Choral Society which he founded in 1949. He led the 28th annual concert in December. Leonard, a tenor himself, was a member of the Choral Society at M.I.T. during his undergraduate days.

Hail and Farewell: In Milan, Italy, **Dino Olivetti**, son of the founder of the Olivetti office machine and typewriter company in Ivrea, died December 24 following an operation. Dino went from M.I.T. to North American Aviation and in 1946 to Italy with his family's company. He was president here in the U.S. of Olivetti of America during the 1950s Since then he has lived in Ivrea where he is survived by his wife and three daughters. . . . **Vallentine D. De Olloqui** died December 31 in Lewisburg, West Virginia.

Dear John: This month's roll calls for news of: John R. Gray, Natick, Mass.; John H. Hollister, Barrington, Ill.; John G. Kelley, Nicasio, Calif.; John T. Kirk, Jr., Short Hills, N.J.; John E. Martin, Chicago, Ill.; John T. Muller, East Falmouth, Mass.; John B. Scalzi, Arlington, Va.; John H. Strohbeen, Fitchburg, Mass.; John E. Tyler, La Jolla, Calif.; and John F. Walter, Des Plaines, Ill. — Frank A. Yett, Secretary, 1405 Ptarmigan Dr., Walnut Creek, Calif. 94595

### 42

First, thanks so much to all of you who replied to our "do-it-yourself" class news form. The news will appear during the next few months.

Sherwood Willard, Jr., is one of the local chairmen for the Boy Scouts of America of the Alleghany (Pennsylvania) Trails Council of the Boy Scouts of America. More than 31,000 scouts and 8,000 adult leaders will attend the National Scout Jamboree there this August. Dan Grady was recently elected President of the Board of Trustees of San Diego Community College.

Carl Zeitz reports that his daughter Majorie was married to Michael Keith and that his son Barney is creating stained-glass windows and has pieces in eastern galleries. Carl expects to become famous as the father of a renowned stained-glass artist any minute. Al Waggoner, who is Vice President of Cutler-Hammer's AIL Division, was recently elected Treasurer of the American Institute of Aeronautics and Astronautics. Pete Grannis writes that he is still Controller of Stanadyne's Hartford Division; Pete and Carolyn have recently had their fourth grandchild, and so the number of grandchildren equals the number of children in their family. Peter Jr. is a Rabbinical student in Jerusalem, Anne designs leather clothing, Timothy is a sucessful silversmith and Stephen is learning to be a farrier and iron worker. John Mueller is still busily looking for a way to reduce America's energy consumption with the Federal Energy Administration in Washington.

Fran Karlan is Assistant Vice President of Metropolitan Life and Associate Professor at Columbia University Dental School. She writes that her daughter is a lawyer with I.B.M., and her son graduated from M.I.T. as a biochemist, Class of '73. Her husband is an engineer with the New York-New Jersey Port Authority and their hobby is traveling — Israel, Brazil, Scotland, Romania, Turkey, Scandinavia, the Far East, etc.

Speaking of traveling, Jean and I just returned from a very interesting two-week photographic safari in East Africa, where we were able to make pictures of all of the Kenyan wildlife except leopards. After the safari, we met the M.I.T. Quarter Century Club trip in Cairo and spent eight days in Egypt. It was another great trip, and doubly enjoyable with three other Class of '42 couples on the journey — Francine and Jim Stern, Betsy and Ken Leghorn, and Hazel and Fred Gander. Perhaps we can get a travel information exchange at the upcoming 35th Reunion.

One obit: Lou Arnold, who graduated with our Class and later received a Master's in business administration from Northeastern, passed away in Nashua, N.H. Lou worked for many Nashua civic activities and was a Rate Engineer with the New Hampshire Public Utilities Committee. We send our sympathy to his family. — Ken Rosett, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

### 44

To those who yearn for the rapidly changing weather patterns for which the Cambridge area is famous, we would like to confirm that the weather conditions that prevail today are no better than they were when you were at Tech. Yesterday while practically all the east coast was basking in the warm sun, we in this area were shivering from the cloudy skies and the penetrating east winds.

Stan Holbrook, who is Director of Engineering for the CRYOVAC Division, has been with W. R.

Grace & Co., Greenville, S. C., for 25 years. Now that both youngsters are married, Stan and Marge have more time to spend on their hobby of traveling. Since they are avid photographers we would guess they have many pictures of their usual and unusual trips to several continents to share.

Thanks to Carl Lindemann, Jr., NBC Vice President for Sports, we'll see on TV the 1980 Olympic games from Russia. Carl is also a member of the National Sponsoring Committee working on behalf of a new Athletic Facility and Special Events Center at M.I.T. Clint W. Murchison, Jr., owner of the Dallas Cowboys, is Chairman of this Committee.

Charles M. Simpson III, President of Protective Coatings, Inc., tells of his two daughters in college: Tobey, a junior at Dartmouth, and Kyle, a freshman at Duke (majoring in engineering). Another daughter, Megan, is a sophomore in high school. . . . From Danbury, Conn., comes a report that James T. Lawson, executive formerly at I.B.M. and General Telephone and Electronics, is now president of E.M.I. Technology Inc., a wholly-owned subsidiary of E.M.I. Limited of London. Jim and his wife live on Lukes Wood Road in New Canaan, Conn.

And from Minneapolis, Minn.: Will B. Rodemann has been named by Control Data Corp. as Vice President and General Manager of domestic operations for the business products group.

William C. Sadler lives in Arlington, Va., and would enjoy hearing from classmates in that area. . Harlan D. Taylor has retired from United Technologies Corp. after a distinguished career. He had been Assistant Director of Research for Finance and Planning there and now intends to direct his knowledge, experience, and expertise to consulting and lecturing.

The Alumni office is seeking the addresses of some members of our class. In a computer run on the "lost children" of Alma Mater, many names are listed. We will try to list a very few of these in each issue with the hope of a response from them or from those who may know how to reach them. We have found one of the lost: M'lis, your cosecretary, is listed. Another name listed is that of Miguel Negrin, and what a story there may be here. His father, Juan Negrin, was the last Prime Minister of the Republic of Spain prior to the Franco Rebellion. Perhaps under the new, reputedly less oppressive, regime we may yet here the name of Negrin again. Here are some of the names: Mario D. Banus, Harvey A. Cox, Jr., Haugan W. Figgis, Joseph A. Henrich, Carl R. Seitz, Jaspar D. Ward III.

We'll be looking forward to seeing you at the alumni luncheon on Technology Day June 10, 1977 (the end of Alumni Week). -- Melissa and Newton Teixeira, Secretaries, 92 Webster Park, West Newton, Mass. 02165

Robert C. Clement is now General Manager of Patents and Licensing for Shell Oil Co. . . . Douglas L. Crinlaw is still with Litton Data Systems Division. Doug's wife works part-time with the mentally retarded at Camarillo State Hospital. The Crinlaw's daughter is in graduate school at T.C.U., and son, Doug Jr., is a lieutenant serving the Navy on the U.S.S. Finback. Doug is in the process of developing an avocado grove to prepare for a second retirement occupation for the years ahead.

A note from Don E. Burke from Florida confirms what we had heard before, that Florida weather from November through January was below par. Don says it still beats shoveling snow and again invites classmates to visit him in St. Petersburg, Florida. . . . Dr. Nathaniel F. Rodman continues teaching in the Pathology Dept. at West Virginia University. The research program there is gradually increasing in importance.... Michael

A. Akel is a senior partner in Akel, Logan & Shafer, Architects and Engineers of Jax, Fla., and also part of Hall Properties, Developers and Builders, also of Jax. Michael is active in the Naval Reserve as Captain in the Civil Engineers Corps.,

and Commanding Officer of E. F. O., Jax Naval Air Station... Dr. Thomas F. Malone has been awarded a Guy E. March Silver Medal as an outstanding alumnus in May, 1976.

Until next time. - Russell K. Dostal, Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

I hope to see you in Cambridge at our reunion. We plan to bring golf and tennis equipment and hopefully will have the opportunity to use both. I don't know how tightly our time will be scheduled. but I plan to get in 18 with Al Richardson.

From the clipping service we are informed that Ted Thomas, who is General Manager of Armstrong Cork's Patent Dept., has been elected Assistant Secretary of that corporation.... Bob Drve writes that he is now a teaching member of the International Transactial Analysis Assoc., and

taught for a spell in Australia.

Earl Iselin is still, as he puts it, "Professoring" at the University of Dayton, and was expecting a third grandchild at Christmas. . . . Wayne Meyer writes from Falls Church, Va., that he was promoted to Rear Admiral in the Navy in 1975. He is Manager of Aeges and Aeges ship projects in the Naval Sea Systems Command, Navy Dept. . Joost Sluis has been practicing orthopedic surgery in Santa Cruz since moving from the San Francisco area in 1971. He and Lois have three children: Anne, a nurse in obstetrics; Bill, majoring in wildlife biology at U.C., Davis; and James, 19, who remains at home. Joost is also President of Christian Cause International, which educates regarding the philosophy, theories, strategy and objectives of totalitarian organizations.

Norman Brown advises that he is currently developing a program of cooperative research, development, and demonstration with developing countries in ERDA's office of international affairs. The program emphasizes small-scale decentralized technologies to exploit removable resources, and to help meet needs of rural areas with a view toward adoption and adaptation for use in the

U.S.

Harold Juckett writes from Columbus, Ohio, where he is Administrative Sales Manager for the Union Fork and Hoe Co., as he puts it, the maker of your favorite Green Thumb lawn and garden tools. He is now involved in Ohio State's aviation program as an avocation only, as he is learning to fly. He asks about some of his fraternity brothers, and I will comment to the best of my ability: Alex Halberstadt, '46, is in construction in Key Biscayne and runs the fraternity football pool. Of our entering classmates I have heard very little in probably 15 years, but I think Tom Huddleston moved north to Tennessee, Whit Mauzy moved south to Tulsa, and Bob Stevens is in the Chicago

See you soon, and if you think of it bring some material I can use next year. - Dick O'Donnell, Secretary, 28516 Lincoln, Bay Village, Ohio 44140

A phone call to Los Alamos brings some news about Jules Levin. Twenty-three years there has provided Jules with many different opportunities. Currently he is managing and in charge of mode access to 600 remote terminals for the Computer Division of the Los Alamos Scientific Laboratory. branch of the University of California now funded by E.R.D.A. instead of the Atomic Energy Commission. Jules' activities are in computers and communications; he manages budgeting and planning. Like many other classmates, Jules is regularly involved in technical firefighting and trouble-shooting. Planning involves user/equipment interaction and selection of additional equipment. Jules has a daughter at the University of California in Santa Barbara. His son will be graduating from college in Pomona next May. Jules asked how Dave Cist was doing; Dave, how about a letter to your class secretary?

I called Ken Parmalee at home in Riverside, Conn., and spoke to Ken's daughter, Beth, since he was away. Ken has five daughters and one son-in-law. Ken is a patent attorney with his practice is based in Stanford, and he is Chairman of the Condemnation Commission in Riverside. He did some sailing a few years ago in the family's Flying Scot. Beth said her dad is excellent in anything he decides to do - whether professional, family, civic, or recreational. Beth graduated from University of Vermont where she majored in teaching. She lives at home and is Secretary of the Conservation Commission in Riverside.

I called Mitch Silverstein for news. Mitch began his company a year after graduation. Today, Specialloy, Inc., is a producer of master alloys and billets that are sold for extrusion and forging. The automotive industry uses large quantities of welding electrode tips fabricated from Mitch's billets. Welded pipe is seamed using a wheel type electrode which is forged from Specialloy's billets. Mitch began furnishing high property copper-nickel alloys for fabrication of components on nuclear submarines at the beginning of the Navy's program. Today this provides regular business for the firm. Mitch has served as chariman of the A.S.T.M. Committee on standards for the materials that his firm produces. Mitch has lectured at Illinois Institute of Technology and in Israel at seminars on Metallurgy.

Mitch's oldest daughter is at Northwestern's Medical School. Next daughter is at graduate school in architecture. His high-school-age son has applied to M.I.T. His son who is a sophomore is considering West Point and is on the track team. His seventh grader is trying to understand why 100 per cent on tests only earns an A and not an A-plus. Mitch and his wife, Hope, were hosts last July of a happening for the Council of Arts of M.I.T. In addition to being hosts of the show, they were celebrating their 25th wedding anniversary on that day. When Mitch and Hope get to Boston they frequently stay at Nancy and Don Noble's

Al Seville sent his first note after 25 years. Since his writing style is better than mine, I quote: "What can you say after over 25 years of nonreporting? I have passed through typical stages aerospace to industrial work; engineer to marketeer to consultant; missiles to helicopters to research and developement to industrial controls to minicomputers. From that first job in the 1949 recession at Bell Aircraft to Kaman to Allied Research to Raytheon - and now since 1964 operating out of my home in Lincoln, Mass., as a management consultant. And that home features Joan (my wife, a going-away gift from Raytheon) and two aspiring skills, Michelle (8) and Donald (who beat the I.R.S. in 1969). Our 'not-so-free' time splits between homeowner suburban syndrome and a ski house in Vermont."

Walter Chaiko, a regular contributor - thank - to this column, writes that he is managing commercialization of a new proprietary product to support mine roofs. Walt is now Venture Manager for Ingersol-Rand. The newly formed Princeton area M.I.T. club has enabled Walt to enjoy renewing some M.I.T. acquaintances.

Dave Brown continues as President of Technical Marketing Associates in Concord, Mass., a management consulting firm. "Just finishing biggest year ever, but it keeps the 'old man' on the run. Have acquired a summer-weekend home in Kennebunkport, Maine - whole family loves it! Proud of #1 daughter, Mrs. Barbara Gould, who will finish doctoral program at M.I.T. in June '77."

Lewis Blodgett writes that he has been at the National Climatic Center in Asheville over 20 years. His oldest son, Lewis III, is a second-year student in forestry at North Carolina State in Raleigh, his next is a high school senior, and the other two are in high school.

Perry Nies was recently elected President of Fourdee Division at Emerson Electric Co., Casselberry, Florida - manufacturer of military electronic equipment: mine detectors, radio beacons, missile batteries, both domestic and international; \$10,000,000/year, sales. Expanding into perimeter and interior intrusion detection.

Charles W. Title is on sabbatical leave from his Professorship of Physics at Southern Methodist



Charles M. Jordan, '49, shows the new style of the experimental Aerovette designed by General Motors.

#### A New Direction in Auto Styling

The 1977 Chevrolet is *Motor Trend*'s "Car of the Year," and Charles M. Jordan, '49, is identified as one of the "key people who share in the distinction of having produced" that car.

Mr. Jordan is in charge of General Motors' Automotive Design Studios, and in Motor Trend magazine he says he and his associates have achieved "a dramatic turnabout in design" for the 1977 models. The 1970s will be regarded as "an era of automotive styling at the crossroads," Mr. Jordan says in Motor Trend, and in 1977 Chevrolet decided which road to take.

Mr. Jordan first achieved success as an automotive stylist when he won the top national award in the Fisher Body Craftsman's Guild model car competition as a sophomore studying mechanical engineering at M.I.T. There years later, having graduated from the Institute, he went to work as a junior designer at G.M.; since then his responsibilities have increased rapidly: Chief Designer in G.M.'s Special Products Studio in 1954, Chief Designer of Cadillac in 1957, Executive-in-Charge of G.M. Automotive Design in 1962, and (also) Director of Design for Opel (Germany) in 1967.

University, to do research in cosmology and neutron physics.

Donato R. Telesca left Grace & Co. to become Director of Manufacturing at Electro-Nucleonics Laboratories, Inc., Bethesda, Md., a health service organization handling cancer virus for cancer research and diagnostic kits for detection of torch diseases.

Leonard Stutman was recently made visiting member of Rockefeller University's Arteriosclerosis Group. — S. Martin Billett, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

49

After an extended period of spring-like weather, the snow reappeared as I was preparing to write this column and clobbered the home-going traffic. As a result, I am in the mood to look ahead to May — and then reminded to invite you all to our annual class cocktail party at M.I.T. on Thursday, June 9. I do not yet have the location, but you won't be far wrong if you check in at McCormick Hall Henge to see you there.

Hall. Hope to see you there. Last December 22, Mary and Jack Baker celebrated their 25th wedding anniversary at a party given by their children, David, Jack Jr., Cindy, Geoff and Carole. Kate and Bob Collins, who also live in Ann Arbor, were among the attendees. E. Vernon Dougherty III writes, recently transferred to Honeywell's Process Control Division in Phoenix, Ariz., where all our family is enjoying our new home and location." Art Halenbeck reports he is now a group director in the Advanced Orbital Systems Division at Aerospace Corp. He has left Malibu for a small condominium and a relatively large sailboat, now that four of his children are in California colleges. Harry B. Keller is a Professor of Management and Director of Graduate Programs in Administration at the College of the Virgin Islands. Now that's a nice winter-time location.

Austin F. Marx reports that he is presently first Chairman of the Long-Range Planning Committee for the United Way of Santa Clara County and is also on the Long-Range Planning Committee for the local Cogswell College, to help apply planning techniques to non-profit organizations. All this in addition to his regular duties as Manager of Corporate Planning and Economics for Hewlett-Packard Co. in Palo Alto. Jim Maslon is still living in Los Angeles; he's Vice President of S.E. Rukoff and Co., in the institutional food business. Elizabeth Taintor Shepard writes that she serves in the Northeastern Connecticut Planning Region as an appointee of the Putnam Planning Committee and with the Connecticut Association of Area Agencies as an elected representative of an area agency on aging. Gene Woodward reports, "My wife, Lois, is spending the (December) holidays at Long Island College Hospital in Brooklyn, N.Y., where she is having an electronic stimulator installed to help her with problems associated with multiple sclerosis. Our children refer to her as their bionic mother! We are encouraged to think a breakthrough is imminent in the diagnosis and prevention of M.S.

A news release reports that Roland E. Derby, Jr., has been re-elected Regional Vice President of the American Association of Textile Chemists and Colorists. He must also be a busy man, as President of Nyanza, Inc., a textile dye and chemical manufacturer; President of the Derby Co. which does research and development in textile dyeing and finishing; Vice President of Nyacol Inc., concerned with the development of inorganic colloids; and as consultant and Technical Assistant to the President of American Color and Chemical Corp.! As Chairman and President, State Street Bank and Trust Co., William S. Edgerly found himself with a column in the Boston Globe on January 2, prognosticating 1977 as a year when Massachusetts will solve some problems. We all certainly hope so.

Thomas J. Lamphier was elected President, Transportation Division, Burlington Northern, Inc., effective January 1, 1977. He joined Great Northern Railway, predecessor of the Burlington Northern, Inc., in 1949 as a Chairman in the

Engineering Department. Along the way he attended the Advanced Management Program at the Harvard Business School. He is also President of Western Fruit Express Company and Walla Walla Valley Railway Co. and Vice President of the Colorado and Southern Railway Co., Fort Worth and Denver Railway, and Burlington Northern Dock Corp. In addition, he is a Director of the First National Bank of St. Paul; Burlington Northern Air Freight Inc.; BN Transport; Portal Pipe Line Corp.; and the Lake Superior Museum of Transportation and Industry!

Robert White, Administrator of the National Oceanic and Atmospheric Administration, was in the news in January. Attending ceremonies marking the designation of M.I.T. as a National Sea Grant college, White reported that the oil spill of the Argo Merchant was not an absolute disaster for the coast or for the fishing grounds, because "we were very lucky indeed."

In response to **Paul Weamer**'s November class letter, two classmates have so far sent in ideas for our 30th reunion: **A. Vanderburgh** and **John P. Horton**. How about hearing from some more of you? Best regards to all. — **Frank T. Hulswit**, Secretary, 77 Temple Rd., Concord, Mass. 01742

50

Alan C. McClure Associates, Inc., was established in 1975, and incorporated in 1976. They now have three M.I.T. graduates on their staff. They offer naval architecture and engineering services to the offshore petroleum industry. ... Robert B. Leonard has completed a two-year assignment as Visiting Professor of Earth Science at New Mexico Highlands University, Las Vegas, N. Mex., for the U.S.G.S. program for minority participation in Earth Science. He is now project chief of the Water Resources Division — geothermal investigation in Helena, Mont.

It is with sadness that we announce the death of Commander Raymond Wiggins. He died November 5, 1976, of a stroke.

Jenson Associates (James T. Jenson) has just opened a Geneva Office for Eastern Hemisphere Energy Planning and Economics Consulting. ... Hansjoerg Stern tells us that he and his family are settling down in their new home in Wilmington. Hans moved from his previous G.E. position in Schenectady to become Manager of Process Technology at the Nuclear Fuel Dept. of the G.E. in Wilmington, N. C. Hans says the challenge of the new job and new field, and the lifestyle of the South are great!

Richard L. Bersin was married to Ruth Hargrave on July 25, 1976. Dick, presently ex-Vice President of International Plasma Corp., Hayward, Calif., travels overseas and domestically to promote sales of plasma chemical process equipment. — John T. McKenna, Jr., Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

51

I have looked forward to sending in notes concerning our classmates. A note from Morgan Foster states, "I founded my own company, Fostermation, Inc. in September of 1971. We are makers of fabricated metal parts for the household appliance and electronic industries." We all wish you well in your business. . . From Herbert Ullman we learned that he organized and chaired a major I.E.E.E. seminar on "Electronics in Nuclear Radiation Environment." We understand it was very successful . . . Bob Lewis just dropped a line to say hello. Thanks Bob, and "Hello."

Just to show how we are moving along — Arthur Krasnow writes his daughter, Judith, received her degree in marketing and management from the Warton School, University of Pennsylvania... Ral Okamoto was awarded a Guggenheim Fellowship for studies in architecture and urbanization. Further, Rai has been appointed as Director of City Planning in the great City of San Francisco. Another fellow Californian who has taken to sunshine... Chuck Maki

writes he is Vice President and General Manager for Electronic Switching Division, Northern Telecom, Inc. in Raleigh, N.C... Continuing up the East Coast Edward Handy relates that he is serving as Community Development Block Grant Coordinator for the City of Cambridge. I'm not exactly sure, Ed, just what you do but it sures sounds impressive.

Did anyone see that article in January Business Week about INFOREX and our own David Caplan? Excellent write up about the Burlington, Mass., company of which David is Engineering Vice President and a driving force.... As for yours truly I have my own printing company who ever dreamed I would get ink under my nails - but one never knows what the future holds. I am also Vice President and Director of Technology Associates of Southern Calif., Inc., a consulting company with over 150 associated fellow M.I.T. alumni. Let's hear from you so we can tell all about your latest adventures. Bye for now. Mark Franklin, Assistant Secretary, Alton Litho Printers, 362 W. Garvey, Monterey Park, Calif.

George W. Stetson III writes that he will be happy to offer any classmates vacationing in Montego Bay, Jamaica, "a tall rum punch to ease the pain. After reading his letter while piles of snow drift outside my window, I am ready to take him up on the offer. George was Principal Engineer with R. W. Beck & Associates of Wellesley, Mass. in 1974 and 1975 doing power plant work. Prior to that he was with Northern Research & Engineering Corp. in Cambridge. Tiring of the rigorous Massachusetts weather, apparently, George retired from active engineering work in the States to the hotel business. His letterhead indicates that he is a consulting mechanical engineer and manufacturers' representative, as well as being responsible for the Holiday House hotel, a few minutes from the airport at Montego Bay. He is also teaching mathematics at a local girls preparatory school.

Still involved in chemicals process design at Chevron Research is Nick Haritatos. He is working on projects including fertilizers, fibers, and industrial chemicals. Nick notes that last spring he spent three weeks in Germany and in his spare time managed to visit several museums and cathedrals. He is active in Cub Scout work and is den "mother" and treasurer.

Clifford M. Sayre writes that he is Planning Manager of Nylon Intermediates for duPont. Cliff is recovering from acute myocardial infarction and comments that Johns Hopkins is a fine medical institution. He hoped to be back to work by March, 1977.... Thomas M. McCarthy is responsible for Product Coordination for the Latin American operations of Procter & Gamble. Tom is based in Cincinnati and previously had several assignments in Procter & Gamble's European Division.

A note comes from John J. Dieckmann, who in addition to his duties as Manager of Engineering for Dunham-Bush, (Harrisonburg, Va., Division), has become Company Program Manager for a major solar heating and cooling demonstration contract funded by N.A.S.A... Howard K. Larson received N.A.S.A's Exceptional Service Medal on November 4, 1976. His achievements are described in an editorial in the December 13, 1976 Aviation Week & Space Technology titled "Laurels for 1976."

William F. Hoey III, writes that he moved from New Haven, Conn., to southern California and is glad to be back on the West Coast. Bill presented professional conference papers last year on Dial-A-Ride (Sixth Annual Conference on Demand Responsive Transportation) and on better use of urban streets. . . . Robert B. Astrachan, under his professional name, Robert Astra, has been certified a Professional in Packaging and Materials Handling by the Society of Packaging and Handling Engineers.

Hello to all from Arthur I. Auer. Art is busy in St. Louis county practicing vascular and general

surgery. He writes that he hopes to see everyone in June at the reunion. . . . Charles M. Saltsman writes that his son entered M.I.T. this year, Class of 1980. Charles III is in TEP fraternity, on the crew, and is studying computer science. Charlie's middle son is at Andover and his youngest is in high school. Charles himself continues as Vice President of Raymond Engineering, Inc., and spends his spare time racing and cruising a 26-ft. sloop and sculpting in wood.

The Boston Herald American reports that Peter R. Leavitt, Executive Vice President of Weather Service Corp. in Bedford, Mass., bet on the cold weather in Florida and bought orange juice contracts. Presumably Peter did very well with his knowledge of weather.

And now news from the college and university world. Darrell A. Frohrib reports that he is Professor and Director of the Design Center Mechanical Engineering Department at University of Minnesota. . . . Arthur J. Freeman writes that he left his position as Associate Director of the Francis Bitter National Laboratory at M.I.T. in 1967 to become Chairman of the Physics Department at Northwestern University, where he is Professor of Physics. He teaches and has an active research group in theoretical solid state physics. Art also edits the Journal of Magnetism and Magnetic Materials for North Holland Elsevier Publishing Co. Rhea is a graduate student at Northwestern and his four children are in fine shape. . . . Jim F. Martin is active in high energy physics research at the Stanford Linear Accelerator Center, Stanford University. . . . Jack Larks is Chairman of Civil Technology at the University of Houston. Jack notes that construction and construction management programs are growing now that Houston has been acknowledged the "Engineering and Construction Center of the World."

M.I.T. conferred Corporate Leadership Awards on 152 of its alumni who are chairmen, vice chairmen, presidents, or managing partners of leading business and industrial organizations in the United States. Those in our class who received the awards are Joseph F. Alibrandi, President and Chief Executive Officer of Whittaker Corp., Los Angeles, Calif., David I. Kosowsky, President of Damon Corp., Needham Heights, Mass; John H. Gerstenmaier, President of the Goodyear Tire & Rubber Co., Akron, Ohio; Phillip H. Smith, Chairman, President, and Chief Executive Officer of Copperweld Corp., Pittsburgh, Penn.; and James R. Reese, President of Hydrometals, Inc., Dallas, Texas.

Dana Mayo, Charles Weston Pickard Professor of Chemistry at Bowdoin College, Brunswick, Me., has been cited in the journal American Laboratory for his computerized method of retrieving infrared spectral data, IRSRCH. The program is a very time-efficient means of confirming or locating the spectra of a relatively pure unknown compound.... Robert A. Boole of Bolton, Mass.,



Robert Boole, '52

has been promoted to Corporate Director of Marketing for Analog Devices of Norwood, Mass. In his new position, Mr. Boole is a member of the Corporate Executive Committee and will be responsible for directing and coordinating the marketing programs for Analog. Prior to joining Analog Devices in 1973, Bob was Marketing Manager for Acoustical Measuring Instrumentation for General Radio in Concord.

We are looking forward to seeing you all at the

reunion next month. - Arthur S. Turner. Secretary, 175 Lowell St., Carlisle, Mass; Richard F. Lacey, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif.

No smashing news, but a few newspaper items and notes which came in with Alumni Fund contributions.

Nelson Lees is now doing double-duty at M.I.T.: in addition to being Director of Resource Planning, he has been appointed to the additional post of Executive Director of Resource Development. Ned joined the Institute staff in public relations in 1959 - following an overseas teaching stint, a tour of duty in Korea and a year of graduate study at Columbia University....

Bruce Murray keeps up his "good press." In January, the American Institute of Aeronautics and Astronautics presented him the Space Science Award "for his outstanding contributions to, and enthusiastic support for, the Planetary Exploration Program." The citation was "for essential participation in the Mariner spacecraft television imaging experiments which led to fundamental new insights on the evolution of the terrestrial planets." (P.S. Don't blame Bruce for the atrocious wording; it is a verbatim quote from the A.I.A.A. news release.) . . . Robert Schultz, in damn near unreadable handwriting, reports that he currently is a solar consultant and manufacturer of solar control systems at (?) DBA Troger Enterprises. . . . Ray Sauer is still with ALCOA in jolly ole Pittsburgh, but he has a new job: Market Manager - Highway, Solar, Duct and Insulation Applications.

On a different theme, Gunther Balz wrote that he Chairman of the Board of Roto Finish Co. (Dare I ask what their line of work is?-Ed.) Also, he has started a wine importing and wholesaling business (primarily French wines); is playing on the national senior tournament circuit; and has published a book of poems. (Now that's what I call living!) . . . Tollyn Twitchell has "good news and bad." On the latter, he is recovering from bust in Florida development boom and architecture; on the former, he's still happily married to Anne and adds that son Jeffrey recently graduated from St. Lawrence with honors and daughter Karen (who enjoys her M.I.T. classes and M.I.T. boyfriend) graduates from Wellesley this June. . . . Charles Brown has had his ups and downs, too. He's President of Summerhomes, Inc., has cruised (by sail) thousands of miles off eastern U.S. but recently sailed into Jacksonville bridge; and has a new baby boy. That's all. Please do write. Anything. - Martin Wohl, Secretary, 7520 Carriage Ln., Pittsburgh, Penn. 15221

Hope the spring finds you with one in your step. Paul Stern is in Tarzana, Calif. - he lives near the chimps. He is Vice President and Resident Manager of the Los Angeles Office of Coldwell Banker Commercial Brokerage Co., directing the operations of 64 salesmen and 20 administrative personnel, the largest sales office within Coldwell Banker. CB is the largest national real estate company, involved in the sale and lease of all classes of commercial and investment real estate. and is traded on the New York Stock Exchauge. Paul is active outside work; he is a member of the M.I.T. Club of Southern California, the Harvard Business School Association of Southern California, and the Richard C. MacLaurin Lodge A.F. & A.M., which is M.I.T.'s Masonic Lodge. Paul also plays tennis, skies, and flies. He even has had time for his lovely wife Marilyn. They have three children, Debbis (10), Adam (7), and Jennifer (4). Drop in on Paul when you get to Tarzana. His house is the one on the left branch of that big oak.

Tom Bastis sends us his aloha from Maui, (for those of you who are uniniated, that is Hawaii) where he has completed three plus years as Maui Manager for H.C. & D. Ltd. He lives at Hookipa Place, Kihei, in his new home, from which he enjoys whale watching and beautiful sunsets. If we get to Hawaii we won't be watching sunsets and whales. But Tom has an artistic soul, and well he should have. He can see the sunset over Lanai from the front of the house, and see mighty Mt. Haleakala from the back of the house. Tom's oldest son, Jonathan, is attending school in Massachusetts, Mark is graduating from high school this year, and only David remains to remind Tom that it is time to go fishing.

LeRoy Malouf is in business on his own in Wilton, N.H. He has organized a network of colleagues, each with expertise in management and organization consulting, and they work on resultsoriented approaches such as improving research & developement effectiveness, positive power and influence workshops, executive selection and career development, gaining organization commitment to priorities, and generating organization superiority and enthusiasm. Those who really want help in motivating their organization into higher profitability might like to contact LeRoy (603-654-9365). He is a tremendously charged-up guy, inspired by a vision of Christ, and with strong support of a loving wife and six children; he makes things happen. -Howes, Secretary, Box 66, Carlisle, Mass. 01741; Assistant Secretaries: Chuck Masison, 76 Spellman Rd., Westwood, Mass. 02090; Lou Mahoney, 14 Danby Rd., Stoneham, Mass. 02180

### 55

Happily, we have received a number of news items accompanying Alumni Fund contributions; they prove that our classmates in Courses II and VI are doing nobly; we would appreciate more news from the rest of you, though.

John Blake (VI) became Director of Environmental Programs for the Power Authority of the State of New York in November, 1976. John describes his job as "coordinating, consulting, and in-house expertise in engineering and science to optimize [the] interface between power generating stations and the air, water, and land environment." Sounds like a weighty and quite difficult task in these days of energy/environment conflict/crisis!

David Peterson (II) has also been enmeshed in environmental problems over the past several years. Since 1972 he has been the Director of the Department of Water and Gas Supply of the City of Duluth, Minn., and he has been directly concerned with the taconite waste discharge problems which have been the source of so much controversy. Your New York reporter, having been before the same court which handled much of the Reserve Mining litigation (on a different matter), can appreciate some of the complexities with which Dave has been burdened. Dave reports that he has recently been charged with start-up of a new \$6-million filtration plant designed to remove the sub-microscopic asbestos particles from the Duluth water supply. Good work and good luck!

Arthur R. Butz (VI), Associate Professor of Electrical Engineering at Northwestern University, is currently a controversial author. In *The Hoax of the 20th Century* he claims, as reported by the press, that the holocaust — the Nazi's extermination of Jews before and during the Second World War — did not occur, "that the 'legend' of the concentration camps is but a concoction of the Zionist movement."..."

Richard L. Forrester (II) has recently been named Director and Senior Vice President of Stone & Webster Engineering Corp. Dick, who is Manager of Stone & Webster's Cherry Hill, N.J., operation center, will also head special companywide projects. He has been with S & W since graduation and has previously served as the company's Chief Mechanical Engineer, Assistant Engineering Manager and, since 1973, as a Vice President. He is a professional engineer in six states and is a member of the National Society of Professional Engineers, the American Society of Mechanical Engineers, and the Atomic Industrial Forum.

Martin Gilvar (II) reports on the personal side

from "Rural Route 1, Oakham, Mass." Marty indicates that his family continues to enjoy the beauties of country living. By the date of this publication John, his oldest, will have completed his college selection struggles — we wish him the best of luck! Meantime, Marty is still "slogging" along as the Director of Development at Morgan Construction Co.

John Rozendaal (XV) writes that he moved to Houston four years ago as a consultant for Pennzoil. Though the consulting assignment was completed in April, 1975, John decided to stay in Houston with his wife Edith and son "Jupi" — a nickname that might call for further explanation. John has been continuing with independent consulting on records management and information retrieval in Houston over the past two years, has enjoyed it thoroughly, has bought a home, and sounds like a dyed-in-the-wool Texan.

Speaking of Texans, I bumped into Bob Temple (X) recently in the TWA Ambassadors' Club at J.F.K. Airport. Bob, who now also lives (at least part of the time) in Houston, was en route, with his wife Cathy, to Madrid in connection with his business in Geneva, Switzerland (Rokko Investment, Ltd.). Bob apparently dabbles in rather exotic activities, his company being involved in a variety of plant design, investment, and installation activities throughout the "third world," particularly Asia and Africa. Those of you interested in professional advice on African photo safaries are advised to consult with Robert, at Western Engineering Co. in Houston. Apart from his travels, Bob has two children at college, at Cornell and Miami, in addition to his youngest, Jennifer, a ripe old 31/2 years.

That's about it for this issue. Since we don't have the occasion to meet many of you by chance in an airport terminal, please send us a note to keep us abreast of your activities. — Co-secretaries: Marc S. Gross, 3 Franklin Court, Ardsley, N.Y. 10502; and Allan C. Schell, 19 Wedgemere Ave., Winchester, Mass. 01890

### 56

Dr. Howard Trachtenberg has a group practice in anesthesia in the Springfield, Mass., area. Before starting there eight years ago he was Assistant Professor of Anesthesia at the Harvard Medical School where he helped establish the Harvard-M.I.T. joint programs in health science research and teaching. The Tractenberg's have three children — 15, 17 and 18; and spend lots of time at their cottage at Quechee, Vt. He has professional contact with Dr. Mac Edwards, who is Professor of Anesthesia and Physiology at the University of Pennsylvania. Howard also sees our Denver surgeon classmate, Dr. Ira Polevoy, perhaps for professional reasons but at least to ski the Rockies.

John Cardinal is Manager of Manufacturing Services at the Hamilton Standard Division of United Technologies — and lives in Longmeadow, Mass., with wife and three children, near an indoor tennis court. . . . Devon Schermerhorn is fully occupied installing a pipe organ in the 18-room house he built for himself in the Berkshires (Hinsdale, Mass.). Until 1970 he was in Aruba with Exxon, where he raised two daughters following his divorce. Now he does occasional house building, furniture craftwork, and operates a small farm in the Tanglewood Festival country — a life style appealing to many of us.

Warren Briggs and his family will be in Athens, Greece, for the coming academic year, teaching for Northeastern University in their M.B.A. program there. He is returning to Northeastern after three years at Bentley College in Waltham, Mass., where he headed the Computer Systems faculty. Renata will be taking a leave from teaching German at M.I.T. for 18 years, and the three children will be in the American School. Warren also taught at the Industrial Management Institute in Tehran during May and June. — Cosecretaries: Bruce Bredehoft, 7100 Lanham Ln., Edina, Minn. 55435; Warren Briggs, 33 Bancroft Rd., Wellesley, Mass. 02181 until September, 1977.

### 57

Here's the news: **Mel Cohen** is now Assistant Director of the Engineering Research Center of Western Electric Co. in Princeton, N.J. His recent activities include Program Co-chairman for an I.E.E.E./O.S.A.-sponsored conference on Laser Engineering and Applications, and the Program Committee of the Topical Meeting on Optical Fiber Transmission. He has also been reappointed to the Board of Trustees of the New Jersey State Prison complex. . . . From Handy &



Don Corrigan, '57

Harmon comes the news that Don Corrigan has been named Vice President for Research and Development. He is responsible for the Metallurgical Dept. as well as the patent and licensing activities of Handy & Harmon and its subsidiary companies. Don was previously Director of Metallurgy and Research since October, 1975. He joined the company in February, 1973 as Manager of Development. His previous experience had been with the corporate research laboratory of Kennecott Copper Corp. as Group Leader of Metal Products, as well as with International Silver Co. and Allegheny Ludlum Steel Corp.... Ed Wasserman dropped us a note to say he has been elected Commodore of the Miramar Yacht Club in Brooklyn, N.Y.... Charles Koch, who is chairman and president of Koch Industries, has been given a Corporate Leadership Award by M.I.T. "to recognize the significance of creative and effective leadership in business and industry in our national life and the role of the private enterprise system in our national character and well-being."

Mitchell Goldman has been appointed head of the Health Facilities Division of Otis Associates, architects in Northbrook, III....John Collins writes, "When I'm not scuba diving and taking underwater photos I am directing the development of communication subsystems (satellite and earth station amplifers) as the Assistant Department Manager, Microwave Subsystems, Hughes Aircraft Co. in Torrance, Calif." . . . And from Alan May, this note: "Seven years ago I moved to Dallas and joined Steak and Ale Restaurants of America, Inc. as executive vice president. It was then a small company with sales of about \$ 3 million per annum. In time we became one of the largest employers of enrolled college students in the nation, most recently employing about 20,000. On average, over these seven years we achieved the highest profit margins of any company in our industry. Our sales exceeded \$100 million last year and in May, 1976, we merged with The Pillsbury Co. Upon concluding the merger, I left to start my own company and am also an active investor in the food service industry. On the civic side, I am a member of the Executive Committee of the Dallas Symphony Association, president of the Dallas Symphony Foundation, and vice chairman of the Executive Committee of the Dallas Theater Center."

Ralph Warburton, Professor of Architecture, Architectural Engineering and Planning at the University of Miami, recently received the N.A.S.A. Group Achievement Award for chairmanship of the H.U.D. Task Force for the U.S. Bicentennial Exposition on Science and Technology, held this summer at Kennedy Space Center, Cape Canaveral, Fla...John Jones has been director of engineering of Disston Corporation since 1974.... The Board of Trustees of Newark Academy, the oldest private day school in New

Jersey and one of the oldest in the country, has announced the election of Dave Staples as the new headmaster effective July 1, 1977. Founded in 1774 by the Reverend Aaron Burr, Sr. (the famous Aaron's father), the Academy, after 190 years in Newark, moved in 1964 to new facilities on 68 acres in Livingston. He is currently headmaster of the Portledge School in Locust Valley, Long Island. Dave, the father of four sons, is a native of Marblehead, Mass. From 1960 to 67 he taught science at the Phillips Exeter Academy, in addition to coaching swimming and football teams there. An outdoors enthusiast, for three summers he was the Seamanship Specialist on the faculty of the Hurricane Island Outward Bound School in Rockland, Maine.

Bob Kyser, Jr. has been elected a principal of Rath & Strong, Inc., a Boston-based management consulting firm with offices also in Chicago and San Francisco. Bob works with clients in the manufacturing and distribution industries on cost reductions or production increases. The work includes economic studies, plant layout and labor productivity improvement. He is an author and speaker to professional societies, a Registered Professional Engineer, a certified instructor by the MTM Association, a senior member of the American Institute of Industrial Engineers and a Certified Management Consultant. Bob holds an M.B.A. from Harvard Business School. He lives in Wellesley with his wife, Nancy, and two children.

— Fred L. Morefield, Secretary, Apt. 6A, 285 Riverside Dr., New York, N.Y. 10025

### 59

Phil Richardson forwarded a letter from Chris Schlemmer. Chris is at a new position as Manager of Corporate Planning for General Exploration Co. in Ohio, which owns and operates oil, gas and coal properties. Chris reported the marriage this past fall of Bob Barbolini in Chicago, where he is Assistant Chief Engineer of Chicago's Metropolitan Sanitation Authority; the arrival of a son, Christoph, to Al Angelbeck and his wife Jeanette in Glastonbury, Conn., where Al is one of the foremost practitioners in laser research for United Aircraft; that Bill Evans is a consultant in Washington, D.C.; and that Cully Gebhart and his wife, Sharon, announced the birth of a daughter, Kristen.

Phil Richardson's activities with Lehman have expanded into the areas of mortgage banking, commercial paper, public finance and small business administration loans. He also has survived a return to skiing after a 22-year lapse!

Michael LoGrande is the Commissioner of Planning and Development for the Town of Islip and the Planning Commissioner of Suffolk County in New York, in addition to serving as a director of the Community Development Corporation... William Cooper is Professor of Information Studies at Berkeley... Malcolm Laughlin is Vice President — P.R.C. Railway Systems of Planning Research Corp... Louis Nelson is Associate Professor and Vice Chairman of the Division of Neurosurgery of Albany Medical College... Walter Humann has been elected President and Chief Executive Officer of Hunt Investment Corp., and actively participates in civic affairs as Chairman of the Dallas Alliance and President of the Dallas Assembly.

Class President Chuck Staples continues to serve as Vice President of Standard Information Systems in Wellesley, with responsibilities for finance, administration and the Multi-Tax division. Standard was recently acquired by United Computing Systems. . . . Ron Willey and family are celebrating the marriage of daughter - time is passing quickly! Ron is actively engaged in instrumentation for solar collector research with Willey Corporation. . . . Tech faculty member Marv Manheim spent a sabbatical year in Paris as Scientific Advisor to the Institute de Recherche des Transports of the French government and as a consultant to O.E.C.D. In the midst of Marv and Margaret celebrating the birth of their first child, Susannah, Marv is finishing a textbook on Transportation Systems Analysis which is to be published by M.I.T Press.

I met Gilbert Chin, who was visiting the Institute to do some recruitment for the materials group at Bell Laboratories. Gil has been with Bell since finishing his doctorate and has published extensively in the field of advanced materials research... Special congratulations to Alan Oppenheim,

Cecil H. Green Professor of Electrical Engineering at the Institute, who has been elected a Fellow of I.E.E.E. for contributions to digital signal processing and speech communications.

Remember, it only takes a short note to any of us. — Phil Richardson, 180 Riverside Dr., New York, N.Y. 10024; John Amrein, 770 Greenwood Ave., Glencoe, Ill. 60022; Adul Pinsuvana, ASEAN Secretariat, 6 Jalan Taman Pejambon, Jakarta, Indonesia; Bob Muh, 907 Chantilly Rd., Los Angeles, Calif. 90024; or myself, Allan Bufferd, 8 Whitney Rd., Newtonville, Mass. 02160

### 60

Three Course X members of our class have joined forces to start Marshall and Pike Enterprises, Inc., a Salem, N.H., manufacturer of thermally and electrically conductive adhesives. Earl Pike is president, Allan Morgan is a stockholder, and David Marshall is in charge of the technical end. The venture is a part-time experience for David, who also is a senior chemical engineer at Ledgemont Laboratories in Lexington. He developed the Marpoxy resin which is used in the adhesives at Ledgemont, and David's and Earl's company manufactures the material under license. David also mentions that he, his wife, Bette, and their sons, David (8) and James (6), live in North Reading.

A son, Chandler, was born on Christmas day, 1976, to JoAnn and **Charles McCallum**; exactly four months earlier, Elizabeth was born to Adair and **Kearny Hibbard**. Charles is chairman of the Grand Rapids Transit Authority and of the local Energy Task Force, and he is continuing law practice. Kearny is treasurer of Thomas & Betts Corp.

Bob DeMichaels, who has been active in M.I.T. alumni affairs, is serving as staff meteorologist to the Aerospace Data Facility near Denver and was recently promoted to lieutenant colonel in the Air Force. . . . Robert (Rusty) Troth is wrapping up three and a half years on the Army staff, where he specialized in mid-range force planning, and he is moving to Fort Devens to command a student battalion. Rusty indicates that he has occasionally run into fellow classmates and "Pentagon denizens," Frank Tapparo and Ben Harris.

Last summer, Ronald Agronin became vice president of Appleton Machine Co. Ron recently was re-elected Chairman of the Board of the Appleton Synagogue and is on the Board of Directors of United Synagogue. His wife, Belle, is the hostess for Welcome Wagon in this mid-Wisconsin community. Ron mentions that he gets to Boston several times each year; on his last trip, he visitied M.I.T. and found the changes in the campus impressive. (Not a bad idea for all of us next time you are in the Boston area, plan to spend an hour or two seeing how the Institute has evolved in the past 17 years.)

Which reminds me that we have a 20th reunion coming up in three years. If you have any specific thoughts about what you are looking forward to when you attend, where it should be held, and so on, share your ideas with us — and while you're at it, send some news. — **Robert F. Stengel**, Secretary, 152 Oxbow Rd., Wayland, Mass. 01778

### 61

Spring came early in New England with two solid weeks of 15°C weather and early crocuses (croaki?) and daffodils. The seasonal fever bestirred some of you to write short epistles. **Peter Gaposhkin** knows little of spring since he lives in the Monterey area where he works for the U.S. Navy Fleet Weather Central. He "furnishes weather data for such users as N.R.L., N.E.P.R.F., and universities." He adds, a bit wistfully, "All my

#### How Green Europe's Pasture for American Investment? Not Very

U.S. investments abroad are down, and — though the trend is far from universal (there are still plenty of special situations of interest) — Raymond J. Waldmann, '60, admits "the bloom might stay off the rose."

Mr. Waldmann, an executive consultant for Harbridge House, Boston, was the wrapup speaker at a conference on "Doing Business in Europe" organized by the World Affairs Council of Boston early in the winter. Preceding speakers had tended to emphasize the negative:

—A generally "depressing" economic situation throughout most of Europe, characterized by unemployment and/or inflation, said Fernand Spaak, Head of the Washington Delegation of the Commission of the European Communities.

—And little prospect for much improvement, said Professor Daniel Yergin of Harvard Business School, because of the growing costs of established socal programs, the intense conflict between labor and management which seems to be resulting in "a stalemate society," and the problems of energy on which most European countries regard themselves as essentially powerless ("the energy game is between the U.S. and Saudi Arabia," said Professor Yergin).

—The growing divergence of morals and ethics between the U.S. and Europe. "In Rome we are not going to do as the Romans do, we are going to do what is expected of the Bostonians," said George Phalen, Executive Vice President — International Division of the First National Bank of Boston, and "this may make us noncompetitive in many areas of the world."

When his turn came, Mr. Waldmann's purpose was to emphasize the positive: there are lots of incentives to foreign - and especially to U.S. - investment in many countries in the form of low-interest loans and tax rebates. In general, they will not go away until the problems these incentives are designed to alleviate - unemployment and inadequate industrial diversification are resolved. Though the total is down, U.S. overseas investment is up in some sectors petroleum, food, transportation, and miscellaneous services and manufacturing. "There will be cases, opportunities, markets, locations which are attractive for the U.S. investor in Europe," Mr. Waldmann said.

relatives in the U.S. still live in Massachusetts."

Also out in the dull world of eternal summer is Alex Moorehead, who lives in San Francisco. He works at Schlage Lock Co. as a systems analyst, and has been there for the past 11 years. He writes that he still dabbles in magic and that his two children are an effective and proven preventative of dull moments.

From lowa, where the weather is too interesting, comes word that **Don Fowles** just published a book entitled *Clinical Applications of Psychophysiology*. Don is Associate Professor in the Department of psychology at the University of lowa... Al Klancnik lives in the Windy City. He sold out his own business, the Merit Manufacturing Co., Inc., a couple of years ago and now is Director of Manufacturing for Sealy, Inc. (the bedding company). He's in charge of manufacturing at 51 plants throughout the world. Wowl ... Richard Williamson has been enjoying the spring in Massachusetts where he has worked at Lincoln Labs for the last seven years.

Finally, **Jerry Milgram** keeps popping up in the news these days. He is still at M.I.T., now as a member of the Ocean Engineering faculty. He is considered an authority on oil pollution and that has been very much in the news here-abouts what with tankers breaking up on the Nantucket shoals. Jerry's face peered at me on an N.B.C. news show a couple of months back; his message was, "pray." Jerry thinks this may be the best course of action unless Congress spends several hundred million to prepare for the next disaster.

With that warming news I wish you a nice month. — Andrew Braun, Secretary, 464 Heath St. Chestnut Hill, Mass. 02167

### 63

A good crop of news this month. The class of '63 must be doing fairly well in the current alumni fund campaign. Our first contribbtions come from the Atlanta contingent. John Brach is now a project manager with the Transit Authority in Atlanta and is still enjoying the life of the city. John's family will have increased to five with the addition of the newest little Brach this spring. John is working on a "good ole boy" Georgia accent, and expects to have it achieved by summer.... Also in Atlanta, Allen Clark was chairman of the Regional Alumni Fund cam-paigns for '76 and '77. He had quite a bit of help from Jim Hadden, who is a professor at Georgia Tech. . . . Stephanie and Steve Bernstein are the parents of a boy and a girl. Steve is leader of the group at M.I.T. Lincoln Labs that develops the new satellite communication ground terminals. . Karen and Marvin Singer vacationed in Martinique this winter, while their son Jonathan vacationed with his grandparents. By the time you read this the Singers will be parents again. Marvin is still working in Washington. . . . Henry Nau is leaving his Washington job with the State Department. He will teach at Stanford University this spring. Welcome to the sunny west! In September of this year he will return to his permanent faculty position as Associate Professor of Political Science at George Washington University.

Joel Schindall is living in California, single again after seven years of marriage. He is division manager at Watkins-Johnson in the Bay Area. Joel is active in est, and is discovering that educa-

tion begins in earnest after you leave college. Ted Cohn has been appointed Associate Professor of Physiological Optics at the University of California at Berkeley. . . . Peter Cleveland and his wife are both in general practice with the medical clinic in Baraboo, Wisc. The second Cleveland child was born at home last year. Peter's country home has many visitors from around the country who are active mountaineers. The best rock climbing in the Midwest is only a mile from Baraboo. . . . Ed Dudewicz recently returned to the Statistics Department at Ohio State University after being a Visiting Scholar at Stanford University. Ed was recently appointed to the editorial review board of the Journal of Quality Technology. He laments the fact that the 'tute has no real statistics department or program.

Enterpreneurs Department — Terry Forster is president of Systems Consultants, Inc., a computer consulting firm. Terry has been in business one and a half years... James M. Conners is Vice President of computer operations at Calldata Systems in Woodbury, N.Y., and Chairman of the Board of Data Reduction, Inc., also in Woodbury.

I had a call recently from Harold Solomon. Hal spent December through March at U.C. San Diego, pursuing his specialty, physical oceanography. This spring he returns to the University of Tokyo. Hal also gave me some information. Lewis Williams is at Avco, and also does some independent consulting. Hal says that Pete Rupp is with Humble Oil in New Jersey. Pete is married and has one child. . . . John McNally is living in Pennsylvania. After two years in the Navy and management training at the University of Chicago, John has made the transition from chemistry to marketing to research management.

A news clipping from the Connecticut Business Journal describes Maurice Andrien's activities as vice president of Kaman Corp., and head of its Music Group. The Music Group includes five music distributors and three manufacturing companies. Mo himself has no aptitude for music, but concedes that one day he may be tempted to take quitar lessons.

A final note: **Bob Starzec** has been appointed Controller of the Central Research Division of Pfizer, Inc., a major pharmaceutical and chemical producer. Bob joined Pfizer in 1968 as a programmer/analyst and has recently been Manager of Research Planning and Analysis. Sounds very serious, organized and responsible. Is that the same Bob Starzec of J-club fame?

Keep those cards and letters comin' in. — Mike Bertin, Secretary, 18022 Gillman St., Irvine, Calif.

### 64

Greetings, Class of '64! This month we were lucky. Jim Lerner is our class hero, having saved us from another "dry month" with no news to print, and we did receive quite a few alumni fund envelopes. (Remember the envelopes serve a two-fold purpose — M.I.T. receives financial aid and we get news of our fellow classmates so '64 can have a column in the Review.)

First to the news from Jim Lerner. After leaving M.I.T. in '64, Jim went to Stanford where in the fall of '72 he received a Ph.D. in aeronautics and astronautics. He decided he had "had it" for the moment and spent the next two years in Europe. While there he traveled extensively visiting such areas as the Greek Islands, France, Switzerland, Sweden and Austria. Jim also did some research for six months at the Swedish Royal Institute of Technology, and attended a three-week session on "Technology, Growth, and the Environment" at Schloss Leopoldskron, a 350-year-old castle in Salzburg, Austria. Jim wrote that "the main purpose of my sojourn in Europe was to think, read, meet people, write and re-consider." Having achieved that purpose, he finally returned to the U.S. in the fall of '74 and started looking for a job in energy and environment. Tune in next month and we'll finish bringing you up-to-date on Jim.

Now to those envelopes: Peter Angevine is traveling quite a bit as a sales engineer for Dorr-Oliver. He enjoys it, although it's tiring at times. His trips take him from International Falls at 31 degrees below zero to Tampa at 75 degrees in two days!... Talbott Hopper is still working as a programmer for IBM in Endicott, N.Y... By the time this goes to print Clarence W. Malick will be remarried. Clarence is still Assistant General Counsel of General Finance Corp., having just moved to Minneapolis where company headquarters are... Joseph Parchesky, his wife Carol and their three daughters have just moved to San Antonio, Texas. Joseph now works for Datapoint Corp. as engineering manager.

C. Alfred Spencer has recently become Manager of Systems Development at Environmental Research and Technology in Concord, Mass... Maury Shulman is still working for IBM

in Philadelphia as a systems engineer. Maury is building a two-room addition to his home in his "spare" time; completion date is scheduled for late 1977.

That's it for this month. Please write and send us news! — Mrs. Steven Schlosser, 11129 Deborah Dr., Potomac, Md. 20854

### 65

Nice letter from **Bill Samuels**, who has been in Brazil for several years as President of APC Skills Do Brasil. It is a managment consulting firm, specializing in productivity and worker skill training. Bill is still single, and apparently enjoying Ipanema on weekends. He has just started a film production company called SAGE. Planning on several more years in Brazil, Bill invites visitors to Rio or Sao Paulo to look him up.

Lot's of '65 offspring are stil arriving. Michael Gabel reports the birth of the Gabel's second son in July; Mike is still Assistant Professor of Math at Purdue. . . . Jane and Allen Pogeler had their first child in September, a boy named Alex; Allen is now Manager of New Business Development for DeKalb AgResearch Corp. in DeKalb, III. . Michael Adler is still working at the G.E. research and development center in Schenectady; the Adlers had their first child, a girl named Emily, in September also. Jean and Howard Ellis had their first son, Jonathan, in time for the Bicentennial: he arrived July 3, 1976. Howard's engineering consulting firm, Enviroplan, Inc., has grown to 17 full-time and 15 part-time employees. The company specializes in air pollution studies. . Joyce and Bill Freed had their second child, Bill Jr., in October.

Channing Stowell brings us right up to date. He married the former Margaret Cross (Wellesley '67) and the Stowells have two children: Julia, 6, and Channing Werner, 3. The Stowells live in Barrington, Ill. and Chan is Group Account Executive for Market Research Corp. of America in Chicago. . . Claire and Neil Lupton have lived in Chatham, N. J., for the last three years with daughter Kate and two cats. Neil was recently promoted to Industry Manager for film, wire, and cable in the Engineering Plastics Group at Allied Chemical. He reports that they are living in a large old house, badly in need of repairs, and are looking for volunteers.

On the work and promotions front, Stephen Williams has just been named Vice President, Planning, at the American Stock Exchange. Steve got his Ph.D. in Math from Tech, was Assistant Professor of Math at the University of Chicago, spent two years as a senior research associate with the Bank Administration Institute, and has been with the Amex since 1972.... Charles Bressel is with the Avco Everett Research Lab, specializing in the design and development of remote sensing systems....Peter Addis is working at Modicon in Andover, Mass, developing microprocessor software for industrial controllers; he is also finishing his Master's in Computer Science at B.U., teaching in the M.I.T. High School Studies Program, and raising gerbils.

Dave Disher is "applying general relativity to geophysics" (and has sold related software to a dozen major oil companies) and has been entered in Who's Who in the South and Southwest... Wayne Thurman completed his M.B.A. at Stanford last June and returned to Bechtel Corp. in San Francisco.... Ronald Smith formed his own solar energy company, Solergy, Inc., and is moving ahead with "increased sales of collectors, testing, certification and initial development of a new heat engine."

Ralph Cicerone, vacationing in Hawaii, writes to say that he has an extra 1965 Technique for the '65er who wanted one....Leo Rotenberg is worried about the Natural Bureau of Standards Data Encryption Standard, calling it so weak that it invites abuse. For further details, see Communic ACM, March '76.

Robert Preer, who went from Tech to Yale for a master's in education, has been recently appointed Director of Affirmative Action at Massasoit Community College in Brockton. When you all write, writing this column is very easy. Keep it up. — **Edward P. Hoffer**, Secretary, 12 Upland Rd., Wellesley, Mass. 02181

### 66

I've just returned from a glorious vacation in Australia, New Zealand, and New Guinea, and recommend all highly. Fortunately for all of you, I have a lot of news this month so I won't bore you with details of the trip.

A piece of late news via the nation's media was the naming of **Rich Breinlinger** as manager of New Product Development of Jewell Electrical Instruments, Inc. The *Manchester Union Leader* article went on to say that Rich was previously with MFE Corp., Conographic Corp., Raytheon

Co., and Bell Aero-Systems.

Manhattan Life Insurance announced that **Dave**Vanderscoff has been elected Vice President and
Actuary. Dave has been with Manhattan Life since
1973. Additionally, he dropped a note reporting
that he received his M.B.A from Adelphi University in 1975 while enjoying the commute on the
Long Island Railroad. Dave and Elaine have two
children, Jessica (9) and Jason (3). Elaine has
stopped her career as an on-call Operating Room
Nurse and has returned to "academia" to seek
degrees in psychology and business administration.

Gervasio Prado writes that he has been at the Draper Laboratory for a couple of years working on navigational systems; he plays tennis with Bob Plindyck, who is a close neighbor in Cambridge. Rick Williams reports that he's now in private practice with a large multi-specialty group doing obstetrics and gynecology. Rick reports that it's nice to live in paradise but doesn't indicate where paradise is located. I vote for New Zealand.

Tim Connelly became a full-time student at Stamford's M.B.A. program last fall while doing part-time consulting at Microform Data Systems. Tim reports that he saw Fred Grahl while Fred was out on a business trip from Pennsylvania. Don Ritter was promoted to Manager of Research Program Development for Lehigh University last July. Bob Large is living in a northwest suburb of Chicago. The Large's have two children, ages 4 and 9. Bob is Chief Metallurgist at Wells Manufacturing in Skokie, Ill.

Richard Cockerill is still employed by the Naval Sea Systems Command in Washington, D.C., and reports that Richard Albert visited him for a short time last summer. Sue and Jack Fuhrer write from Princeton, N.J.: "Jack is still involved with Selecta Vision at R.C.A., and is busier than ever. In his spare time he has become interested in woodworking. We spent last summer hiking and climbing through the Pacific Northwest and Western Canada. Our children, Carolyn and Jonathan, aged 7½ and 3, continue to grow and bring us joy."

Bob Poole reports as follows: "Recently (late '76) founded the Local Government Center in Santa Barbara, Calif., as a nonprofit research center studying innovative methods for improving the delivery of public services at lower cost. Am writing a monthly newspaper column, 'Fiscal Watchdog,' on local government issues -- so far appearing in 50 newspapers. Served as coordinator of Juvenile Justice Task Force for Santa Barbara County, developing a master plan for juvenile justice/delinquency prevention programs. Continue to edit and and publish Reason magazine, circulation now 18,000." Ken Dritz has been at Argonne National Laboratory since leaving Tech, for the past two years working on program transformation systems - which led to a six-week trip to Moscow last year. His long-term project to photograph all the wild flowers of the Chicago Region continues strong, with 600 species in hand as of December, 1976.

Michael Marks dropped me a line last week conveying the following: "Last summer we moved from Acton to Lexington, Mass. We have really enjoyed our new home, and with more horses passing by than cars we are also enjoying real country living while still being just a short ride

from the attractions of Boston. As for work, I'm a vice president of Technical Marketing Associates, a management consulting firm in Concord. Susan and I, Jenny, Amy, and Daniel would be delighted to hear from any old friends in the area or passing through."

Eleanore Klepser, Assistant Secretary, called Anne Kazanow Dershowltz when she visited Connecticut recently. Anne's husband is now an Actuary for Security Connecticut Life while she is an adjunct faculty member at the University of Hartford. They have two girls, aged 4 and 1. Anne has kept in touch with Suzanne Degner whose husband, Gerald, is at Yale. The Degners have two children, a boy and a girl. Anne was looking to hear from Virginia Lee, but her address is not on the Class list. Finally, Bill Klepser bumped into Margaret Chatterton last week.

Last but not least, **Ken Browning** sent me a clipping from *Tech Talk* discussing etchings and woodcuts by Nancy R. Davidson, **Ralph Davidson**'s wife, which were on display at the M.I.T. Faculty Club during the month of January. Ralph is presently a member of the M.I.T. Corporation. All those who have easy access to the Institute should make an effort to get hold of the February 2 issue of *The Daily Reamer*. Ken was featured quite prominently as the subject of this issue, and it even shows a 12-year-old picture of him, crew cut and all. I cannot personally talk to the recruiting ad on page 11 of that issue.

That's all for now. Keep the news flowing and I promise not to spend future issues discussing my vacation. — Paul Rudovsky, Secretary, 340 East 64th St., Apt. 10B, New York, N.Y., 10021

### 67

Our class reunion will begin with cocktails and a buffet on Friday, June 10, and will conclude with a Sunday brunch, June 12. Plan to attend.

John Ebert has been keeping active with tennis during the summer and racquetball and skiing in the winter. Last summer he captained a 39-foot sloop in the British Virgin Islands. . . . Penny and John Halberstadt and their three children, John Jr., Ellie and Drew, are doing well in Wilmington, Del. John received his M.B.A. from University of Delaware in 1976 and was elected to Beta Gamma Sigma. His thesis was entitled "Opportunities for U.S. Business in Soviet Agriculture." John works in employee relations with DuPont. Also with DuPont in Wilmington is Larry Galpin. The Galpins should have their second child by the time you read this. . . . The consulting firm of Chandler Stevens, Jr., Participation Systems, Inc., is developing a science resource network for the Massachusetts legislature. . Having ended four years of temporary work at the National Bureau of Standards, Richard Stein is convinced that private industry is the way to go. Until he also convinces an employer, he intends to catch up on his skiing....Joe Alsop joined Marketing & Research Counselors of Dallas as systems development manager. The Alsops are expecting their second child.... John Patterson flies the A-4 Skyhawk out of Norfolk, Va. His son, John Edwin, was born October 19.

Bill Murray is a senior consultant in the Denver office of Anistios, the risk management consulting division of Alexander & Alexander. Having moved from Rochester, N.Y., to Colorado, Bill is lobbying to outlaw any further migration to God's country from the East, especially from New York. He reports that such a law would have considerable local support, in spite of constitutional problems. . Jan and Dave Sanders have a new home in Los Gatos and a beautiful new baby, John David, born October 16. We enjoyed a good dinner in their home recently, and John was the big attraction. Dave works at Hewlett-Packard.... Mel Snyder is a chief neurosurgical resident at U.C.L.A. Medical Center, and Janice is completing a doctorate in counseling education at U.S.C. They have two children....Liz and Richard Haberman are proud to announce the arrival of their son, Ken, born October 29.... Nancy and Jimmy Sutton and their daughter, Jorun, are still living in Santa Clara, Calif. Jimmy has been working for IBM Research for a couple of years while trying to finish his Ph.D. at Stanford and move to the Santa Cruz Mountains. . . . Stan Rose changed jobs last May and is now in charge of all minicomputer consulting for Automated Concepts in New York City. Stan, Louise, Stephanie and Jeffrey live in New Jersey. — Jim Swanson, Secretary, 669 Glen Rd., Danville, Calif. 94526

68

Rob (Ph.D. '70) and Margie Keller have moved from San Diego to L.A. Rob teaches physics at Long Beach State while Margie has a fellowship in pediatric immunology-infectious disease at Harbor General. She reports meeting Tessa Orellana who is in Chicago finishing an infectious disease fellowship. . . . Another coed in the same area is Shan Cretin who is living in Santa Monica with her husband, Emmett Keeler, and daughter, Mikala. After graduation she "bounced around the eastern academic circuit: a master's from Yale, a Ph.D. from the 'tute, and then some teaching at Harvard." She is now teaching operations research at U.C.L.A.'s School of Public Health. . A few hundred miles north, Dave Pearson is working for Electromagnetic Systems Labs in Sunnyvale. He reports enjoying the sailing, skiing and year-round tennis of sunny California. ... Another sunny place, with very different politics, is Victoria Falls, Rhodesia, where Paul Forbes is working on the construction of a new power house. He is engaged to a Rhodesian girl and hopes to bring her back to the States soon, depending on the political situation.... But not everyone can live in sunny climes. Robert Mitchell is working at the National Center for Atmospheric Research in Boulder as a senior system programmer and is developing an operating system for the Cray-1 super computer which they have on order. After leaving M.I.T. he received an M.S. in computer science from the University of Colorado. - Gail and Mike Marcus, Secretaries, 2207 Reddfield Dr., Fall Church, Va. 22043

69

Rodney G. Riek (best goalie the Lambda Chis ever had) reports that he picked up a J.D. after night study at Suffolk University in Boston while working on the D.S.R. staff at M.I.T. He is now working in St. Louis, Mo., for ITT Blackburn Co. as a project manager. He and his wife Barbara have a year-old son named Jason.

William N. McLeod, by now an old hand at the Office of Management and Budget, is still at his stand there. He frequently sees Bob Dresser, '72, who, according to Bill, is in the O.M.B. working on "various defense projects." Usually reliable sources (Dresser) report that Dresser is now at the S.E.C. Bill's daughter Lindsay is now 2.

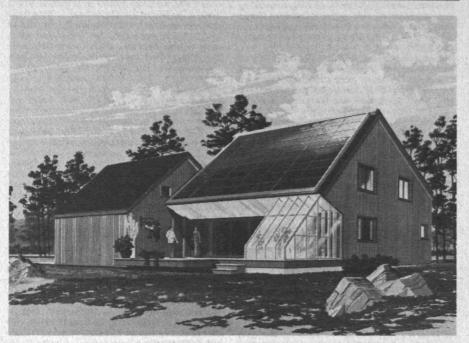
Franklin P. Rogers received his M.B.A. from Washington University in St. Louis and has moved back to his home town of Belleville....Thomas A. Schonhoff is working in various communications systems programs at GTE Sylvania in Needham, Mass. He is working on the modeling of a Hybrid Time/Frequency Demand Assigned Multiple Access Satellite System.

Jeffrey M. Weissman and his wife Linda report the birth of their first child, Karen Michelle (7 lbs., 5 oz.), on March 6, 1976. Jeff further wrote: "We heartily recommend natural childbirth to all who may be considering it. A wonderful experience."

... Kathryn (Kanarek) James is working at Analytical Systems Engineering Corp. in Burlington, Mass. Her husband Hugh, Ch.E. '74, is manager of technical development for J.F. Pritchard and Co. in Kansas City. They spend their weekends commuting.

Peter L. Eirich is working for the Logistic Management Institute of Bethesda, Md., on "aircraft inventory modes."... Talal Kheir is "getting prepared to be involved in contracting work in Saudi Arabia and would like to know if anyone is interested."

Bruce H. Parker is a systems engineer for



The fuel bills for this new home in southern New Hampshire will be only 20 per cent of those for typical homes nearby, says Bruce N. Anderson, '69, President of Total Environmental Action, Inc., of Harrisville, N.H. Mr. Anderson's firm is devoted to energy conservation, and this house — it's called Goosebrook, and it incorporates solar heating, off-peak electric stored heat, and other

energy-saving features — is a "Federal Solar Demonstration Project" of the Department of Housing and Urban Development. Goosebrook was designed by Mr. Anderson and his associates with help from the Public Service Co. of New Hampshire, National Science Foundation, and Energy Research and Development Administration.

#### An Energy - Conserving Demonstration House on the Market in Peterborough

Goosebrook, a solar home built in Peterborough, N.H., to demonstrate solar heating and other energy conserving systems, is nearing completion and will be sold this spring. It's a product of Total Environmental Action, Inc., of Harrisville, N.H. — a research, design, and education firm dedicated to energy conservation by its founder and President, Bruce N. Anderson, '69.

Goosebrook is a three-bedroom (oneand-one-half baths) residence with an attached two-family garage, built by George Bogosian and Co., Nelson, N.H., with traditional financing by the Peterborough Savings Bank. But there's nothing else traditional about Goosebrook: all told, says Mr. Anderson, Goosebrook's fuel bills will be less than one-fifth those of a conventional residence of similar size.

Seven reasons, says Mr. Anderson:

- Goosebrook is a compact home, with "judicious" placement of doors and windows.
- There's lots of extra insulation. The walls are  $2'' \times 6''$  studs with insulation between and one-inch styrofoam sheathing, and three inches of insulation was

applied to the exterior of the basement walls.

- Triple-glazed windows are used on the east, west, and north.
- Construction joints are carefully sealed.
- Large expanses of glass on the south side of the house are backed by six-footlong water tubes in which heat is stored.
- A roof-mounted solar collector with a combination storage, heat transfer, and heat delivery system is designed to efficiently use low storage temperatures.
- A "Megatherm" off-peak electric system is used for supplementary heat. Charles J. Michal, Jr., '72, Project Manager for Total Environmental Action, Inc., explains that the "Megatherm" is a large, pressurized water tank, heated electrically to "fairly high" temperatures. But it draws current only at night, during off-peak hours, storing that energy for use as heat whenever it's needed.

As construction of Goosebrook concludes this spring, Total Environmental Action, Inc., will hold workshops and seminars for builders, contractors, bankers, realtors, and architects. And Mr. Anderson and his colleagues will continue to monitor Goosebrook's performance for its owners after the property is sold.

I.B.M. in Washington, D.C. His family has grown to three with the addition of a son in December.

... Sandy Mathes is being kept busy at home with her sons Andy (3) and Benjy (10 months).

That's it gang. Keep those letters and postcards coming. — Peter Peckarsky, Secretary, 950 25th St., N.W., Washington, D.C. 20037

70

I received a letter from Ron Abramson who hopes that his classmates still remember him. Ron left the Ph.D. program in chemistry at Cal-Tech to practice corporate law. Before working for the New York office of a Palo Alto law firm, he did two research stints in the medical-related fields and received a J.D. from Rutgers Law School in Camden. . . Maxim Daamen is just finishing his residency in Psychiatry at Tufts-New England Medical Center and will practice in Boston. The University of California at Irvine will be the location of the radiology residency of Allen Cohen. He graduates from a Ph.D.-M.D. program at the University of Miami in June.

On the more leisurely side of life, Howard Hoffman writes that racing his Hobie Cat has made him regret not having tried sailing in his college days. . . Leland Schaeffer, Jr., traveled extensively throughout eastern U.S.S.R. He believes people basically act the same everywhere and he also suffered from a chewing gum shor-

tage and "Big Mac Attacks."

Philip Selwyn is now Program Manager in the Defense Advanced Research Projects Agency, having left the Institute for Defense Analysis....

Tommy Ebe has been elected President-elect of the Chemical Notation Association and is Senior Associate Editor at Chemical Abstracts Service. ... Bridge appears to be the main avocation of

Louis Zarfas and his spouse Jane Edwards. His talents include community theater involvement, drawing cartoons, and scrutinizing patents at the U.S. Patent Office.

Stephen Loeb has been appointed Assistant Corporation Counsel for the city of New York. . . . Procter and Gamble, which claims the services of several of our classmates, has promoted Albert Geyerer to Brand Manager of Coffee Advertising. Presumably, not an easy task at prices over \$4.00 a pound. Albert recommends a scuba diving and sailing vacation in the Virgin Islands. . . Ralph Albanese has opened up his own architectural office, married Nancy Santucci, and will be a father in July.

Grumman Aerospace Corp. has employed Thomas Kelly as Vice President of Engineering. . . Bill Wong has joined the National Bank of North America's International Division after working for Marine Midland and Chemical Bank. Bill and his spouse Shu Ping live in Brooklyn with their two children.

I just finished building a grandfather clock. Maggie purchased two "Bicentennial" model bicycles and we plan to enjoy Sean's first summer on those. — Robert Owen Vegeler, Secretary, 2120 Fort Wayne National Bank Bulding, Fort Wayne, Ind. 46802

71

Avi Ornstein was at M.I.T. for the A.P.O. initiation and saw Len Tower, Bob (Jock) Young, '72, and Kevin O'Brien. Len is working for The Tech, Jock went skiing with Gary A. Wade who lives in California. Avi is teaching high school science and plans to include a course in pure math. He's also a member of the Natural Resources Council of the League of Women Voters. He's supporting a bottle bill in Connecticut.

David Meharry received his Doctor of Engineering degree from the Helsinki University of Technology, and is the father of Elizabeth Talvikki (along with his wife, Marja)... Jeff Cooper started an acoustical consulting firm that specializes in the design of recording studios. Jeff has worked designing studios for Chicago, America, and Jose Feliciano, among others. He not only designs and supplies the blueprints but

also supervises construction and interfaces all the recording equipment... H. Debose Montgomery, Jr. writes: "I am now one of four principals in a new \$20-million venture capital fund which my firm recently organized. We will be looking to make investments in the range of \$250 to \$750 thousand in small growth companies primarily on the West Coast." He welcomes inquiries from M.I.T. grads. He's playing tennis and working on a new house he bought in Hillsborough, Calif., and is Vice President of the M.I.T. Club of Northern California

Richard A. Mathias is Vice President of Macotech Corp. in Seattle, Wash.... David A. Spear is working on research and development for fire detectors... Richard Stat, 725-A Norway Rd., Chadds Ford, Penn. 19317, would like to hear from Clifton Chang about his real estate work.

Please write in when you have some news about yourself or other members of the class. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, Tex. 77833

72

Bruce Frank writes, "I married Enid Weisberg on February 1, 1976. Last May I graduated from Washington University School of Medicine in St. Louis followed by a medical internship in Milwaukee. In July I will move back to Boston to start an ophthalmology residency at Tufts for the following five years." . Marc Gorenstein is at Berkeley working for a doctorate in physics, specifically in astrophysics.... Don Bryant got his Ph.D. in molecular biology from U.C.L.A. and has a postdoctoral fellowship to study in Paris at the Pasteur Institute with Dr. Roger Stanier.... Michael Cohen spent two years with the Peace Corps in Peru as an agricultural planner and another nine months there working for the Dutch Technical Mission, reading, mountain climbing, and travelling. There followed a three-month trip through Bolivia and Brazil. . . . Richard Pitts is Actuarial Associate with State Mutual Life Assurance Co. in Worcester. . . . Gordon Shecket got his M.D. last year from Case Western Reserve.... Scott Cutler is working at the G.E. Research and Development Center in Schenectady.... Clifford Ananian is working for B.E. & K. in Birmingham, . Roger Mecca has his M.D. from Alabama. . New York Medical College and is interning at Westchester County Medical Center.

Mark Haberman writes, "I am in the first year of the Ph.D. program in clinical psychology at the University of Wisconsin. I arrived here by an unusual route — a Course XXI concentration in philosophy, a year's work in a psychiatric hospital, a B.S. in biology, an M.S. in Course XX, and failure to get into medical school. Then, after some hard thinking, I chose the equally onerous field of clinical psychology — and got in! I couldn't be happier in this field, which should combine hard-nosed research with soft-hearted clinical work (but doesn't). Incidentally, Bob Ebert is here as a second-year student in clinical psych."

Conor Reilly graduated from Harvard Law School two years ago and is now in New York with Cravath, Swaine, & Moore. . . . Jim Blankenship got his M.D. from St. Louis University last year. . . . Joseph Edwards succeeded Bill Hecht as Director of the M.I.T. Educational Council; he has been a Regional Director for the Alumni Association. . . Karl Lamson is working at Lamson Surgical Supply Co. in Barre, Vt. . . . John Krzywicki is an attorney with Sullivan, Jones and Archer in San Francisco and is Vice President of the M.I.T. Club of Northern California. . . . Thomas Zebehazy is Senior Experimental Engineer in the Engineering Analysis Department, Chevrolet Engineering Center, Warren, Mich.

James Mosora reports, "Completed U.S.A.F. Squadron Officer School at Maxwell A.F.B.; selected for promotion to Captain and regular Air Force commission; drinking beer, and loving life." ... Robert Reiter finished his M.S. and is working for a Ph.D. in computer science at the University of Maryland. He was married to Louise Ebbert (Garland Jr. College '72) this May... Gary

Chirlin is working as a biological systems analyst at the Smithsonian's estuarine research facility on the Chesapeake Bay. "The center is turning the corner, moving into substantial scientific efforts," he writes, "and I am processing and analyzing much of the acquired data."

Yong-Yong Tam has an internship at San Francisco General Hospital and will be returning to Boston in July.... William Botherton is an intern at Overlook Hosptial in New Jersey and will be a resident at Columbia Presbtyrian starting in July.... Michael Callahan writes, "I'm progressing - occasionally in the formal direction toward my doctorate in instrumentation at M.I.T." ... Kathy Swartz writes, "I finished my Ph.D. in economics at the University of Wisconsin in October. This year I am teaching at the Graduate School of Public Policy at Berkeley. This summer I will be moving to Washington with my husband and will begin teaching in the Economics Department of the University of Maryland. - Dick Fletcher, Secretary, 135 West St., Braintree, Mass. 02184

73

It may surprise a great number of '73ers to see something for us in the Class Notes. A lesson to you all — never complain about something unless you're prepared to do it yourself. I did, and now I am. Your new Class Secretary, that is. So now I am sitting here with a foot-thick stack of correspondence to sort out and report. If yours is not here, there is a reason. Much dates back to April, 1976, or earlier, and is too dated to pass along. I strongly recommend that you try again soon — but, please, not all at once!

Dean North is foresaking the big city life for Monroe, Mich., where technology is helping the Michigan Basin yield up its hydrocarbons... James Reuss: "Same address, same wife, two new cats. Que sera." . . . Sidney Henderson has returned from six months wandering through Africa and is off to San Diego for med school and marriage. . . . Mike Schulman should receive his Ph.D. by the turn of the century, but meanwhile is enjoying S.F.... Robert Klein, armed with an M.S., will seek his fortune in sunny California. "I'll be living near Santa Clara with a wife, a cat, and a lot of comic books." . . . Jose Soloom has been transferred to the American embassy in Rabat, Morocco, as an economic/commercial officer for three years. . . . Thomas Harrison, after studying human leukemic cells for three years, has entered U. Mass med.

T. W. Johnson was "saved in October, '74, and married in July, '75. Still in the Air Force." Jean Ward has been doing a lot of singing on stage lately. Six weeks in Pirates of Penzance with Boston Light Opera; the beggar in Fiddler on the Roof at M.I.T., and the bos'n in the B.U. Savoyards' HMS Pinatore. Yours musically was also in those three productions. . . . Fred Dopfel got a master's from Stanford in '74 and now consults in D.C. He is coaching a girls' softball team.... Doug Levene is news editor of the Boonton (N.J.) Times-Bulletin, after an M.A. from Yale in East Asian Studies. . . . Linda Mayeda was in Ghana for two years in the Peace Corps teaching chemistry in secondary school. She is now M.B.A-ing at Dartmouth.... John Lippitt received a Master's from Lesley in May and is teaching fifth-graders in Cincinnati. Those who remember him know he looks as much like a fifthgrade teacher as the M.G.M. lion looks like my aunt Agatha. . . . Sally Boyson is a second-year med student at Penn Med, married to John Fetrow, a fourth-year student at Penn Vet School. Abbott Stillman created his own firm, the Stillman Group, for community development, real estate, etc., in New York.

Marty Romeo, R.N. (Regular Navy, not you know what) is assigned to Norfolk Naval Ship-yard, shipping navals under Adm. Westfall, '48. . . . Jack Levy works for the Beacon Companies as a researcher, looking for ex-BTBs for Patriot's Day DTYDs. . . . M.D. Knauer has been transferred by D.E.C. to Puerto Rico with Kathy and 1-year-old Katie Beth. . . . Malcolm Hill has won the

#### Scholz and "Boston": Nearing Superstardom

When Donald T. Scholz, '69, finished his Master's degree in mechanical engineering in 1971 he went to work at Polaroid Corp. on mechanical details of "picture-in-aminute" cameras. But he liked to make music, and he liked to fiddle with the electronics to record his songs, and finally the product of his most elaborate, 12-track system caught the ear of the industry.

From then on it was a short jump to success with Epic Records - a single disc. "More Than a Feeling," and a hit album, "Boston," both in the "top ten" by the end of last year - and a leave of absence from Polaroid. Now he's touring with "Boston," playing lead, acoustic, and special-effects guitars, bass, organ, and percussion; and after more than two columns in Time (November 15) and some enthusiastic reviews ("a group heading for the top," says the Manchester (Conn.) Herald), the Polaroid engineering job may wait a while. David B. Koretz, '78, of The Tech, who caught "Boston" in Boston this winter, says it's "destined to become rock's next supergroup."

Waters Student Research Award for his work on Alaskan Rocks. . . Brian Moore is alive and well with wife Dede in Windsor, Conn., working for Combustion Engineering Inc. designing nuclear safety systems. . . Steve Nadler is a fourth-year med student at McGill. . . Scott Brown has joined the firm of Daniel Wagner Associates in Paoli, Penn., as an O.R. consultant.

H. I. Feuerstein is finishing Columbia Law School and has accepted a job with the New York law firm of Fried Frank, Harris, Shriver and Jacobson for the fall. . . Steve Kamerman is, as expected, an attorney in New York also, working with his father. . . D. J. Moylan is completing his senior year at Georgetown med school, destined for residency training in Internal Medicine. . . Joel Bergman is a quality control analyst for Manufacturer's Hanover in New York, developing programs and instructing on them. . . Alan Lawee joined the Cygnet Computer Group in Montreal doing great amounts of skiing. For himself, not for Cygnet.

James Masiak is a project engineer at the Noise and Vibration Lab at the G.M. Proving Ground in Milford, Mich... Wallace Scott has an M.B.A. from Berkeley and works as a production engineer for Automatic Measurement Division in Sunnyvale, Calif., and takes courses in Computer Science at Stanford... Dwight Davis received his M.B.A. from Cincinnati in June.... Doron Holzer and frau had a son, their first, on July 3... Jose Lopez is manager of engineering and production for a pipe fabrication shop in Satelite, Mexico.

Lee Giguere writes from Hartford, where he is photo editor of the Journal Inquirer after two years in Anderson, S.C., ostensibly interviewing Jim Rice's family. Lee also bears the year's sad note; that Alan Precup, of Aurora, Ill., was killed in Alaska as the result of an attack by a bear while camping in Glacier National Monument. Alan was a civil engineering graduate who had just finished law school at Michigan, and planned to work for a firm in San Francisco. His classmates and friends all offer their deepest condolences to his family. Tony Scandora is working in the Chicago area, ignoring his old friends and better come to Boston to see ALNM in May!

Yours truly - ah, yours truly - is working for Burroughs in Boston as an associate account manager, marketing terminal devices to hospitals; not surprising for a dropout med student (North Carolina, '77). After turns as a waiter, maitre d' at Whimsey's, taxi driver, church soloist, statistician for Mass. M.V. Registry, and dinner theatre performer, I'm working. I'd done, during that time, over 150 performances in this area with all the local Gilbert and Sullivan troupes, and a few less reputable outfits. Currently I'm working as Henrik in a Harvard production of A Little Night Music which goes up for two weeks starting April and write! - Robert M.O. Sutton, 28. See it -Secretary, 37 Fairbanks St., Brightor., Mass.

74

Well, at last a 1974 Class Notes column. A lot of news is piled up, so get ready. Robb Collier is studying oceanography in the joint M.I.T.-Woods Hole program and will be taking doctoral exams quite soon. Robert Armbruster is attending Tufts University School of Medicine - he is in his third year. John Nickerson has finished his master's at Michigan State and is working on a Ph.D. in human genetics at the University of Texas Medical Branch; John will be married in June to Kathy O'Neill. Joe Whittle is the Project Engineer for the new Tampa bypass portion of Interstate I-75 for Law Engineering Testing Co. David Leinweber is expecting a Ph.D. in mathematics this June from Harvard; he developed a computer system to monitor voter turnouts for the Carter-Mondale campaign and is consulting for Massachusetts state government on regional energy models.

Arnold Roane has been promoted to Manager of Operational Planning in the Data Communications Department of General Electric Co.,

Waynesboro, Va. Sheva Stern is in her second year at Jefferson Medical College in Philadelphia.

Roger Goldstein has written me: "I'm now working for a small architectural firm in Newton, Mass.... Three weeks ago (12/26/76) I was married to Cindy Beck of Short Hills, N.J., who is an art specialist in the Quincy Public Schools... In addition to my architecture job, I am maintaining a freelance photography business which I started while at M.I.T. Life is very good."

Robert Maunus has written that he has received a master's in biology and will return to Boston in June, 1977, actively seeking employment in bio research. He says, "I would greatly appreciate any hints or offers sent to me at 12316 Tonsing Dr., Garfield Heights, Ohio, 44125." In return for my printing his address here, Robert has given me information about other classmates. Stan Shursky has his M.S. in civil engineering and is working in Middletown, R.I... Paul Shapiro is working on a Ph.D. in Ocean Engineering at M.I.T... Dan Greene is going for an M.S. at Case Western Reserve University while working for Union Carbide in Clevelend, Ohio.

Paul Schlinder writes: "I have laft UPI, written a book on aspirin (to be published this fall), and joined the Bank of America as a public relations officer in San Francisco. I am engaged to be married this August to Carol Franz, Simmons '75, in San Francisco."

William Dobbins is currently teaching physics at Connecticut College. Arvind Khilrvani is in the Ph.D. program in engineering-economic systems at Stanford University. Michael Moreau is in his last year at Georgetown Law School and has accepted a position as law clerk with the Federal District Court in Philadelphia. Hugh James has joined J.A. Pritchard and Co. as Manager of Technology Development. David Vogel has completed his master's in bioengineering and is continuing on for his Ph.D. at Michigan. Charlie Bruno is finding the working world too easy compared to work at "the 'tute."

Peter Dietz is electrical engineer for the General Electric Research and Development Center. Iver Cooper has won first prize in the 1976 Nathan Burkan Memorial Competition at the Boston University School of Law. John Tierney has received the Associate designation in the Casualty Actuarial Society by passing six comprehensive insurance examinations.

And I will be married this June to Susan Sokalner, Mount Holyoke '72. — Dennis Dickstein, Secretary, 17 Forest St., #34, Cambridge, Mass. 02140

75

I'm sorry I missed the March/April issue, as I actually had some news to report. But at the time of my deadline back in January, I was busy preparing for my written doctoral exams in biochemical engineering (which I passed) so I just couldn't find the time to prepare a column. Forgive me if some of these items seem a little stale by now.

Ken Johnson is living in Palo Alto, Calif., and has been in Stanford's Department of Operations Research since October, 1975. He has finished a master's degree and has decided to transfer to Berkeley for further graduate work in tranportation next year. Some of his spare time has been filled playing alto saxophone in the Incomparable Leland Stanford, Jr., University Marching Band; from the looks of a picture Ken enclosed, the band does seem incomparable. He says that "the Bay Area reminds one of Harvare Square at its weirdest. It's as musically exciting as Boston-Cambridge with plenty of opportunities to hear the Grateful Dead and jazz. The Bay Area has an excellent reputation, and deservedly so; it's hard to say whether I prefer it to the Cambridge we know and love.

I heard from **Tom Hui**, my regional representative in New York who's in his second year at N.Y.U. Medical School. This is his report: "I hear regularly from **Eve Higginbotham** who's tooling away at Harvard Medical School, **Dong Park** who's at Albert Einstein, and **Barbara Freeman** 

and Vincent Leung at Mt. Sinai Medical School. Dave Lee is completing his M.S. at the University of California at Berkeley and coming back east. Dave says that Dave Hawke is also back east after getting an M.S. at Cal Tech. Also out in California is Jason Wong, who is a graduate student at Berkeley. Finally, I hear from Yosuki Mishiro, who's working in Tokyo for the Mitsuibishi Co. He says he has finally adjusted to a businessman's style of living. He and five or six other '75 alumni had a small reunion in Tokyo over the summer."

Chris Dippel and Chris Santos (Wellesley, '74) were married on December 23, 1976, in Brighton, Mass. Belated congratulations! . . . Dave Katz has become a full-time employee of AIDJEX (Arctic Ice Dynamics Joint Exp.) and is also a part-time student. Says Dave, "It is due to a request for someone to do what I was doing as research assistant. So I'm getting a lot of money for the same work."... Jeff Schweiger is currently undergoing Fleet Replacement training with Patrol Squadron 31, Naval Air Station, Moffett Field, Calif.: "By March, 1977, I will be serving with Patrol Squadron 19, Moffett Field, as a Navigator/Communicator on P-3C Update 'Orion' anti-submarine warfare patrol aircraft." - Jennifer Gordon, Secretary, 5 Centre St., Apt. 32, Cambridge, Mass. 02139

76

I have some mail for a change. William Luyties, whom I haven't seen or heard from since our freshman year, writes that he married his fiance Susan (Wellesley '76) during our sophomore year and moved into Westgate, and after a year there, to the Back Bay, thereby becoming isolated from his fellow classmates. He took the S.B. and S.M. degrees in Course I in four years and last summer started work with Shell Oil in New Orleans: ' spent the first six months on a training assignment where I worked in the production department, went offshore a lot, and took some classes It was interesting, and I learned about the oil industry first hand. Since December I have been working in the Offshore Civil Engineering Group. We handle day-to-day type civil engineering, such as platform installation, platform modifications, checking members for loads, etc. Everything but the actual platform design." He eventually hopes to move into platform design, however.

Also, I have a letter from **Hal Berman**, who is now a graduate student at U. Mass., Amherst, working on a master's degree in manufacturing engineering. He has found that "courses and project work are both excellent." He also writes that "**Bob Quirk** is alive and well and working through Navy nuclear school."

I bumped into Elliot Chartash, who has been vacationing in Florida. He told me that Richard Inz and Harry Frisher are both at Columbia Law School and doing well. Mark Snyder visited Elliot in New York over Christmas, coming from U.C. Berkeley, where he is a graduate student in biochemistry. Elliot has also spoken with Lee Silberman, and reports that Lee and Todd Marder are both chemistry grad students at U.C.L.A. Hopefully, someone is going to mail me a postcard from California.

I espied Phil Giangara a few days before this column was due and managed a few words with him. He reports that he is 6-1A at the Naval Underwater Systems Center in Newport, R.I., and is working towards his S.M. He is captain of M.I.T.'s table tennis team, while in Cambridge, and is thinking of resuming singing some choral music down in Newport. I asked him if he had seen the mansions, and he confessed he was too lazy! He expects to start work full-time at N.U.S.C. in June upon completion of his thesis. This will be a considerable change from last summer, when he rode his bike 1,500 miles. He hopes to do even more this summer. He also told me that last winter he took up skiing, and, after just a couple of months, he goes down expert slopes with great pleasure and skill.

Some more letters will certainly be appreciated. Don't be shy. — **Arthur J. Carp**, Secretary, 67 Badger Cir., Milton, Mass. 02186

#### THIRTEENTH ANNUAL TOUR PROGRAM — 1977

1977 marks the thirteenth year of operation for this unique program of tours, which visits some of the world's most fascinating areas and which is offered only to alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Univ. of Pennsylvania, Columbia, Dartmouth, and certain other distinguished universities and to members of their families. The tours are designed to take advantage of special reduced fares offered by leading scheduled airlines, fares which are usually available only to groups or in conjunction with a qualified tour and which offer savings of as much as \$500 over normal air fares. In addition, special rates have been obtained from hotels and sightseeing companies.

The tour program is consciously designed for persons who normally prefer to travel independently and covers areas where such persons will find it advantageous to travel with a group. The itineraries have been carefully constructed to combine as much as possible the freedom of individual travel with the convenience and savings of group travel. There is an avoidance of regimentation and an emphasis on leisure time, while a comprehensive program of sight-seeing ensures a visit to all major points of interest. Each tour uses the best hotel available in every city, and hotel reservations are made as much as two years in advance in order to ensure the finest in accommodations. The hotels are listed by name in each tour brochure, together with a detailed day-by-day description of the tour itinerary.

The unusual nature and background of the participants, the nature of the tour planning, and the quality of the arrangements make this a unique tour program which stands apart from the standard commercial tour offered to the general public. Inquiries for further details are invited.

#### **AEGEAN ADVENTURE**

23 DAYS \$2250

This original itinerary explores in depth the magnificent scenic, cultural and historic attractions of Greece, the Aegean and Asia Minor, including not only the major cities but also the less accessible sites of ancient cities, together with the beautiful islands of the Aegean Sea. Visiting Istanbul, Troy, Pergamum, Sardis, Ephesus and Izmir (Smyrna) in Turkey, Athens, Corinth, Mycenae, Epidauros, Nauplion, Olympia and Delphi on the mainland of Greece, and the islands of Crete, Rhodes, Mykonos, Patmos and Santorini in the Aegean. Total cost is \$2050 from New York. Departures in April, May, July, August, September and October 1977. (Additional air fare for departures in July and August.)

#### SOUTH AMERICA

28 DAYS \$2675

From the towering peaks of the Andes to the south Atlantic beaches of Rio de Janeiro, this tour travels more than ten thousand miles to explore the immense and fascinating continent of South America. Visiting Bogota, Quito, Lima, Cuzco, Machu Picchu, La Paz, Lake Titicaca, Buenos Aires, the Argentine Lake District at Bariloche, the Iguassu Falls, Sao Paulo, Brasilia, and Rio de Janeiro. Total



cost is \$2675 from Miami, \$2691 from New York, with special rates from other cities. Departures in January, February, March, April, May, July, September, October and November, 1977.

#### THE ORIENT

29 DAYS \$2645

A magnificent tour which unfolds the splendor and fascination of the Far East at a comfortable and realistic pace. Visiting Tokyo, the Fuji-Hakone National Park, Kyoto, Nara, Nikko and Kamakura in Japan, as well as the glittering temples and palaces of Bangkok, the metropolis of Singapore, the fabled island of Bali, and the unforgettable beauty of Hong Kong. Optional visits to the ancient temples of Jogjakarta in Java and the art treasures in the Palace Museum of Taipei. Total cost is \$2645 from California with special rates from other points. Departures in March, April, May, June, July, September, October and November, 1977 (extra air fare for departures July through October).

#### MOGHUL ADVENTURE

29 DAYS \$2575

An unusual opportunity to view the magnificent attractions of India and the splendors of ancient Persia, together with the once-forbidden Kingdom of Nepal. Visiting Delhi, Kashmir (Bombay during January through March), Banaras, Khajuraho, Agra, Jaipur and Udaipur in India, the fascinating city of Kathmandu in Nepal, and Teheran, Isfahan and the palaces of Darius and Xerxes at Persepolis in Iran. Total cost is \$2575 from New York. Departures in January, February, March, August, September, October and November, 1977.

#### THE SOUTH PACIFIC

29 DAYS \$3140

An exceptional tour of Australia and New Zealand, from Maori villages, boiling geysers, ski plane flights and jet boat rides to sheep ranches, penguins, the real Australian "Outback," and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand and Canberra, Melbourne,

Alice Springs, Cairns and Sydney in Australia, with optional visits to Fiji and Tahiti. Total cost is \$3145 from California. Departures in January, February, March, April, June, July, September, October and November 1977.

#### **EAST AFRICA**

23 DAYS \$2310

The excitement of Africa's wildlife and the magnificence of the African landscape in an unforgettable luxury safari. Visiting Lake Naivasha, Lake Nakuru, Samburu Reserve, Treetops (Aberdare National Park), Masai-Mara Reserve, the Serengeti Plains, Ngorongoro Crater, Nairobi and Mombasa. Total cost is \$2310 from New York. Optional visits are available to the Amboseli and Tsavo National Parks, the Victoria Falls, on the mighty Zambezi River between Zambia and Rhodesia, to Zanzibar, and to the historic attractions of Ethiopia. Departures in January, February, March, May, June, July, August, September, October, November and December 1977.

#### MEDITERRANEAN ODYSSEY

22 DAYS \$1925

A unique and highly unusual tour offering a wealth of treasures in the region of the Mediterranean: Tunisia, with the ruins of Carthage and many other Roman cities as well as lovely beaches, historic Arab towns and desert oases; the beautiful Dalmatian Coast of Yugoslavia, with its fascinating and medieval cities; and the 17th and 18th century splendor of Malta. Visiting Tunis, Carthage, Dougga, Sousse, Monastir, El Djem, Gabes, Djerba, Tozeur, Sbeitla, Kairouan and Thuburbo Majus in Tunisia; Split, Trogir, Sarajevo and Dubrovnik on the Dalmatian Coast of Yugoslavia, and Valletta and Mdina in Malta. Total cost is \$1925 from New York. Departures in March, April, May, June, July, September and October, 1977 (additional air fare for departures in June and July).

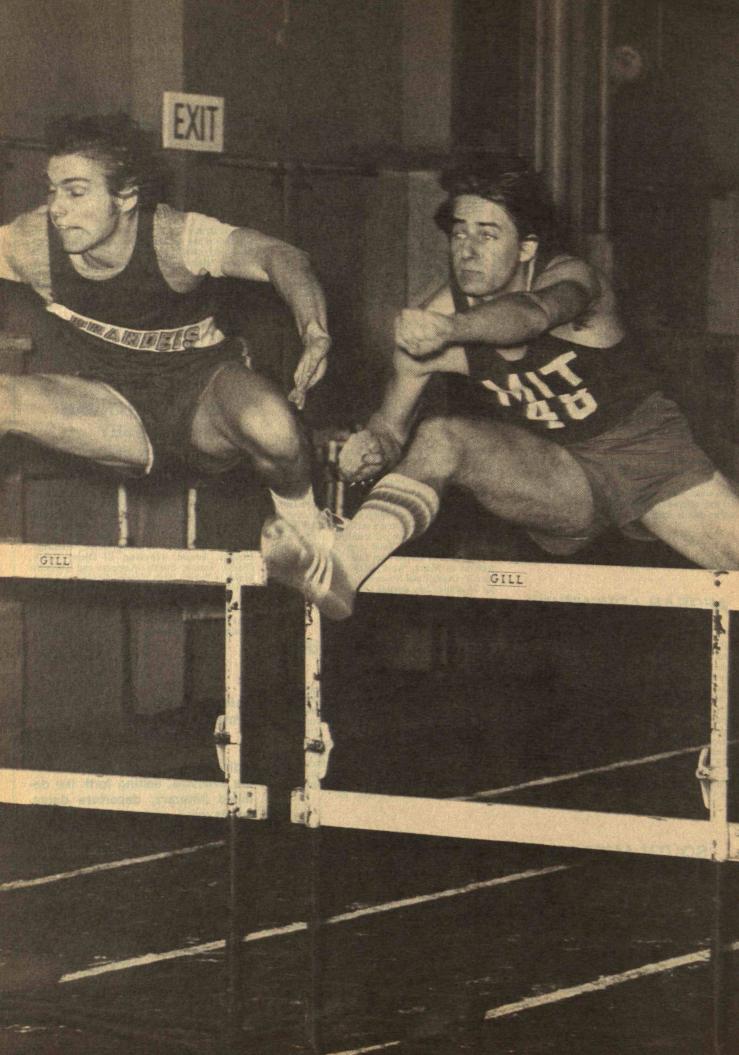
Rates include Jet Air, Deluxe Hotels, Most Meals, Sightseeing, Transfers, Tips and Taxes.

Individual brochures on each tour are available, setting forth the detailed itinerary, departure dates, hotels used, and other relevant information. Departure dates for 1978 are also available.

For Full Details Contact:

**ALUMNI FLIGHTS ABROAD** 

White Plains Plaza One North Broadway White Plains, N.Y. 10601



#### Students

#### All-American Honors in Fencing and Swimming

Though we may want to forget the weather, we'll be a long time forgetting the sports in the 1976-77 winter season. It was a good one for lots of people and teams at M.I.T.: - Mark Smith, '78, won the Eastern Foil Championship, and the men's fencing team was sixth in the National Collegiate Athletic Association Championships at Notre Dame in March; for the second time in history, the varsity fencers were All-American. Mr. Smith won N.C.A.A.'s George Coint Award as "the finest sportsman in the tournament.

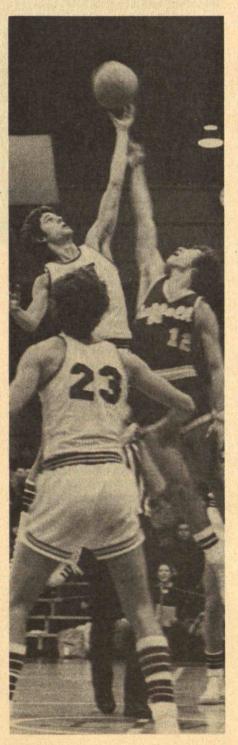
- Judith Austin, '77, co-captain of the women's fencing team, finished 25th in a field of 120 at the N.C.A.A. Women's Fencing Championships. Only the top 24 competitors moved into the final rounds, but Jill A. Gilpatric, Director of Sports Information, thinks it was "quite a performance for a girl who has only been fencing since her sophomore year."

- After "spectacular" performances at the New England championships, five varsity swimmers travelled to the N.C.A.A. Division III championships at Oberlin, and three of them came back with All-American honors. Preston Vorlicek, '79, set a new M.I.T. record in the 100-yard breaststroke, and Richard M. Ehrlich, '77, and Robert W. Hone, '79, were the first M.I.T. divers ever to win All-American honors.

- All high honors at the New England sectional meet went to the M.I.T. pistol team. which defeated Worcester Polytechnic Institute, the Coast Guard Academy, and the University of Massachusetts by decisive margins.

- Without a winning season for over a decade, the hockey team bounced back to an 11-7-1 record - and that's with the home rink outdoors, where "the cold biting winds of winter can really get to you," said Gary S. Engelson, '80, in The Tech. Only one loss marred the indoor track season.

Opposite: Jim Turlos, '80, represents M.I.T. against Brandeis. Right: Rich Van Etten, '78, next years Cocaptain, leaps for the ball against Suffolk University. (Photos: Jet)



### Beesley, Gendron Associates. Inc.

Management Consultants Industrial Managers

George Beesley '39 Richard P. Gendron

441 Statler Office Building Boston, Mass. 02116 Telephone: (617) 423-3632

# The Ben Holt

**Engineers and Constructors** Planning and feasibility studies
Design and construction of facilities for the energy Industries Specialists in geothermal technology

Ben Holt, '37 Edward L. Ghormley, '47 Jaime J. Gonzalez, '66

201 South Lake Avenue Pasadena, California 91101 (213) 684-2541

#### Brewer Engineering Laboratories Inc.

Consulting Engineers
Experimental Stress Analysis, Theoretical Stress Analysis, Vibration Testing and Analysis, Specialized Electro-Mechanical Load Cells and Systems, Structural Model Testing and Fabrication, Strain Gage Conditioning and Monitoring Equipment. Stanley A. Wulf '65 G.A. Brewer '38, Marion, Massachusetts 02738 (617) 748-0103

### Capitol Engineering Corporation

Consulting Civil Engineers

Robert E. Smith '41 Edward W. Boggs '56

Dillsburg, Pennsylvania 17019

### Charles Nelson Debes Associates, Inc.

**Engineers and Consultants** 

Structural, Electrical, Mechanical, Acoustical, Industrial, Commercial and Municipal Projects

C N Debes '35

915 East State Street Rockford, Illinois

### J. H. Clausen, Ph.D.

CONSULTING IN CHEMICAL TECHNOLOGY

Environmental Analysis and Monitoring, Feasibility and Impact Studies, Process and Product Evaluation, Product Safety, Occupational Health, Industrial Hygiene, O.S.H.A., Legal Technical Assistance, Complete Laboratory Services.

P.O. BOX 203, LEXINGTON, MASS., 02173 (617) 646-0220

#### Fay, Spofford & Thorndike, Inc.

Engineering for Government and Industry

Ralph W. Horne '10, William L. Hyland '22, Edward C. Keane '22, Charles V. Dolan '31, William J. Hallahan '32, Fozi M. Cahaly '33, George M. Reece '35, Charles R. Kurz '48, Bruce Campbell '49, Paul J. Berger '50, Max D. Sorota '50, Rodney P. Plourde '68, John C. Yaney '72

One Beacon Street, Boston, Mass. 02108

# H. H. Hawkins & Sons Co.

building contractors

Steven H. Hawkins, '57

188 Whiting Street Hingham, Mass. 02043 (617) 244-8111

#### People

#### Alumni Involvement: What, How, Why

"Love, respect, valued associations" — it sounded like a love story. These words were repeated often as active alumni expressed their motivations and involvements in M.I.T. affairs to a group of undergraduates during Independent Activities Period last January.

The theme: what is the Alumni Association — and why become involved?

The answer: the Alumni Association has many facets; and this variety is a source of satisfaction and fulfillment for many participants.

One becomes a member simply by attending M.I.T. for at least one term. The Association keeps track of about 60,000 out of 66,000 living alumni (2,000 are added each year). It sends speakers and arranges functions for 80 M.I.T. clubs around the world (ranging in size from as few as ten to 400 or 500, such as the M.I.T. Alumni Center in New York City). And it is the nucleus for groups of alumni volunteers, ranging from the Association's own Board of Directors (the elected governing body of 15 people who meet four times a year) and the Alumni Council (a body of 300 to 500 committed people who meet seven times a year), to the regional councils throughout the U.S. organized in support of the Alumni Fund. In all, there are 3,000 alumni volunteers around the country. Theirs is a twoway interaction with M.I.T. with mutual benefits.

One popular role for alumni is in the admissions procedure, as members of the Educational Council. "If we just wanted the brightest students," says James A. Champy, '63, Executive Vice President of the Alumni Association, "we could do it by scores. But marks are not the only criteria. We try to find out what they want to get out of school, what their interests are. Most alumni want to get involved with this — there are scores of volunteers to work with high school people."

Meeting People and Repaying Debts

Perhaps the discussion most relevant to new alumni was about the feelings generated by participation. For Harl P. Aldrich, Jr., '47, service on the committees to plan activities, like Technology Day, gave him the most satisfaction. "It is the opportunity to continue old associations and friendships — and to make new ones," he says. He feels that alumni have a role in bringing the real world into the academic world. "I have a great respect and fondness for M.I.T. I've traveled extensively abroad — and as you go further from M.I.T. and as the years go by, you'll find M.I.T. extremely highly regarded in all circles. And you will treasure an M.I.T. degree."

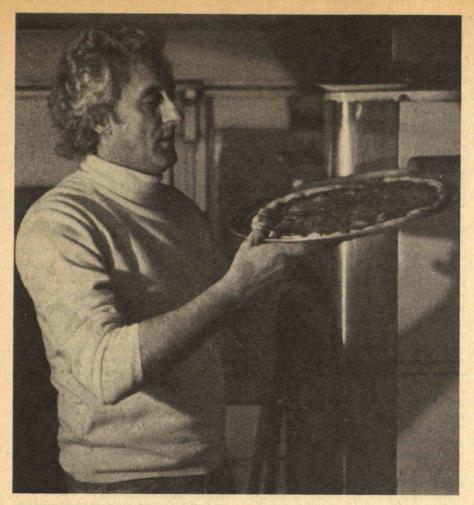
"Being an alumnus is more fun than being a student," says D. Reid Weedon, Jr., '41. "Even fund-raising is fun — it's the opportunity to meet people on a one-to-one basis." (Mr. Weedon is now involved in his third capital drive.)

llene S. Gordon, '75, participates because she spent four undergraduate years working part time in the Alumni Association. She feels she is paying M.I.T. back for that opportunity.

Claude W. Brenner, '47, says he finds it difficult to say no to M.I.T. requests. "The Institute respects its alumni for reasons other than their ability to give money. As alumni, we have a responsibility to return something to future generations of what we gained from our experience at M.I.T."

Mr. Brenner remembers his student life: "We who were here 30 years ago value the 'Tech is Hell' reputation. It wasn't really, but we loved to tell parents about it. (I wrote it on my first 20 letters home)."

He is concerned about students now and feels there is something alumni can do about the sense of some students that life at M.I.T. is austere, in spite of the richness of activities, "that it can be frightening in its aloneness, and forbidding - the gray factory on the Charles." His class established a fund at his 25th Reunion to improve the quality of student life. The host family program is part of that - students have the opportunity to meet with an alumni family in the Boston area. He feels alumni can advise students on career development, too. But this is controversial, he adds. "No matter what you elect to do you never end up doing that. You can never foresee the twists and turns of a career. Students should hear that."



## Paul E. Dutelle & Company, Inc.

Roofers and Metal Craftsmen

153 Pearl Street Newton, Mass.

### Lord Electric Company Inc.

Electrical contractors to the nation since 1895

Headquarters: 45 Rockefeller Plaza New York, N.Y., 10020

Offices in 16 principal cities throughout the U.S. and Puerto Rico

Boston Office: 86 Coolidge Avenue Watertown, Mass. 02172 (617) 926-5500

Mr. Brenner feels the present involvement of alumni, 3,000 out of 60,000, is not enough. One suggestion: a formal program of alumni visiting professors, to involve more alumni who have things to teach in freshmen seminars.

Mr. Brenner concludes with the objectives of alumni involvement: "to serve the Institute, to enjoy ourselves, to meet students, to give back what we gained, and to participate in individual ways to continue our identification with M.I.T."

And his reasons: "I owe a great deal to M.I.T. It is an institute I value above all others, a source of great pride to me to continue to participate in its life. Because it's fun, it is my principle hobby (although I do have others). And I have a sense of honest duty and obligation simply because I love M.I.T." — M.L.

#### A World Record with \$16.50

The world record for "elbow coin catching" — 66 quarters — now belongs to David Gaskin, '79. Elbow coin catching? Balance the coins on your right elbow, then flick your arm and catch the coins — all of them — in your right hand. Mr. Gaskin has been practicing since junior high school, and it took him nearly two hours of attempts to reach the remarkable total of 66 at 1:18 a.m. on February 6 in Baker House.

To fill hungry students' orders, Joseph O'Keefe makes 75 or more pizzas a night in his green and red pizzeria on wheels in which he visits East and West Campuses. The recipe? asked The Tech. An old one . . . a friend taught him, is all he will say. (Photo: Gordon Haff, '79, from The Tech)

#### 75 Pizzas a Night for 16 Years

The phenomenon is "somewhat like Pavlov's dogs," wrote *The Tech*: "Two bells ring out and people start salivating."

It's a familiar and wholly normal reaction, for the bells signal the arrival of Joseph O'Keefe, who's been peddling pizzas to hungry M.I.T. "tools" from his pizza oven on wheels for 16 years — ever since pizza slices sold for 15 cents each.

Now, covering both West and East Campus houses during the evening hours, Joe makes an average of 75 pizzas a night — and more during finals. In 16 years that might work out to nearly 300,000 pizzas.

The Tech's reporter found — as have generations of students — that "it's easy to like Joe. There's a warm, little chuckle at the end of his phrases. He's one of those people that one can't imagine not being cheerful."

## Syska & Hennessy, Inc.

Engineers

Mechanical-Electrical-Sanitary Elevator & Materials Handling

Specialty Divisions: S&H Information Systems, Inc. Engineering Management Division Lighting Design Workshop Site Planning-Automation John F. Hennessy, Jr. '51 110 West 50th Street New York, N.Y. 10020

1720 Eye Street, N.W. Washington, D.C. 20005 1900 Avenue of the Stars Century City Los Angeles, California 90067 4, Rue de Penthievre

75008 Paris Jordan Road, Boulevard Saba No. 40 Tehran, Iran

# Steinbrecher Corporation

Consultants in Electrical Engineering and Related Areas

Communications Technology Analog and Digital Electronics Precision Instrumentation Acoustics and Auditory Perception Manufacturing Facilities Available

D. H. Steinbrecher, '62 R. H. Domnitz, '67

73 Pine Street, Woburn, Mass. 01801 (617) 935-8460

### Albert E. Hayes, Jr., Ph.D.

Consulting Engineer Filter and Network Design

Electromagnetic Compatibility Proposals, Studies, Reports EMI Test & Control Plans System Design Supplier Liaison Test Surveillance Reliability Studies

Albert E. Hayes, Jr., '42 P.O. Box 2946 Fullerton, Cal. 92633 (714) 992-4841

# TAD Technical Services Corp.

Contract Engineering Services

Offices in: California Illinois Maryland

Massachusetts

New York Pennsylvania Texas Virginia

Home Office: 639 Massachusetts Avenue Cambridge, Massachusetts 02139 Telephone: (617) 868-1650

### A New Director of Materials Science and Engineering



M. Dresselhaus

Mildred Dresselhaus, Abby Rockefeller Mauze Professor who is an expert on solid-state physics, will be Director of the Center for Materials Science and Engineering beginning on July 1. She will succeed Nicholas J. Grant, Sc.D.'44, ABEX Professor for Advanced Materials, who's been Director of the Center since 1968.

Professor Dresselhaus has been a member of the Center since she joined the faculty in 1968; for two years, from 1972 to 1974, she was Associate Head of the Department of Electrical Engineering, and throughout this period she has been a leader in the solid-state field and in developing enlarged opportunities for women in science and engineering. Her husband, Gene F. Dresselhaus, is a theoretical physicist, a member of the staff at the Francis Bitter National Magnet Laboratory.

Professor Grant will return to full-time teaching and research in physical metallurgy; he's an authority on heat-resistant materials and their manufacture. The Center which he has directed funds and coordinates interdisciplinary research in materials by some 50 members of the faculty and at least 100 graduate students each year.

### A Communications Expert Heads Lincoln



W. E. Morrow, Jr.

Walter E. Morrow, Jr., '49, who has been Associate Director of Lincoln Laboratory since 1972, has been named Director; he succeeds Gerald P. Dinneen, who resigned as Director upon being nominated by President Carter to be Assistant Secretary of Defense (see March/April, p. A28).

Mr. Morrow is an expert on space communications, one of Lincoln Laboratory's primary research areas. He joined the Laboratory's Long Range Communications Group upon completing his S.M. in electrical engineering at M.I.T. in 1951, and he has continued in this field ever since while assuming increasing responsibilities in the administration of the Laboratory. He holds the Armstrong Achievement Award of I.E.E.E.'s Communications Society "in recognition of innovative contributions to space communications."

### **Kerman Heads Theoretical Physics**



A. K. Kerman

Francis E. Low, Professor of Physics, has completed his four-year term as Director of the Center for Theoretical Physics, and he has been succeeded by Professor Arthur K. Kerman, Ph.D. '53.

The Center — it's now approaching ten years old — provides a focus for the research and teaching of some 60 theoretical physicists at M.I.T. — members of the faculty, research staff, postdoctoral workers, and graduate students. Most of the work is in nuclear physics, particle physics, and astrophysics; there's a small effort in the theory of condensed matter.

It is Professor Kerman's task to maintain "the very strong interaction between the theorists working in these fields" which Professor Herman Feshbach, Ph.D. '42, Head of the Department of Physics, says has been "most fruitful ... a unique achievement of the Center."

Professor Kerman studied mathematics and physics at McGill University (B.Sc. 1950), where he received the Molson Gold Medal in Mathematics and Physics, and then came to M.I.T. for graduate work with Professor Victor F. Weisskopf. He's been a member of the faculty since 1956 — and in the meantime has held fellowships or visiting professorships at the Institute for Theoretical Physics in Copenhagen, the University of Paris, the State University of New York at Stony Brook, and Brooklyn College.

### **Individuals Noteworthy**

Counselors: Officers, Directors, Advisors

John J. Guarrera, '43, of the School of Engineering and Computer Science, California State University in Northridge, Calif., to Vice President for Professional Activities of the Institute of Electrical and Electronics Engineers . . . Donald W. Male, S.M. '58, to the Board of Trustees of the Unitarian Universalist Association . . . Alan H. Cohen, '61, to Vice Chief of Staff of Los Alamitos General Hospital in California . . . Arthur M. Poskanzer, Ph.D. '57, senior chemist at the

Lawrence Berkeley Lab, to Chairman of the Division of Nuclear Chemistry and Technology of the American Chemical Society. Herbert L. Carpenter, Jr., '44, Director of Research for Greif Bros. Corp., to Vice President.

Charles C. Park, '50. Executive Vice President of the Gleason Works, to the Board of Trustees of Keuka College ... Thomas A. Hood, '45, Executive Vice President of Vermont Marble Co., to President of the Vermont State Chamber of Commerce. . . . Robert C. Casselman, '39, to Associate Director of the Museum of Fine Arts in Boston . . . Marvin E. Goody, '51, to Chairman and John M. Clancy, '56, and Robert J. Pelletier, '51, to members of the Mayor's Arts Commission for the City of Boston. . . . James C. Bresee, Sc.D. '53, to Director of the Division of Geothermal Energy of the Energy Research and Development Administration. . . Edward E. David, Jr., S.M. '47, vice president of Gould Inc. in Chicago, to President-elect of the A.A.A.S.

Harry Washington Fritts, Jr., '43, Professor and Chairman of the Department of Medicine, School of Medicine of the State University of New York at Stony Brook, to the National Heart, Lung, and Blood Advisory Council of the National Heart, Lung. and Blood Institute. . . . Ray C. Burrus, '22, to the Central Planning Committee of the South Campus of the Broward Community College, Hallandale, Fla. . . . John R. Whitford, '49, to President and Chief Executive Officer R.E.L. Incorporated . . . Joseph C. Fengel, '60, Executive Vice President of Nuclear Energy Systems, Westinghouse Electric Corp., to the Board of Directors of the Atomic Industrial Forum. . . . Matthew M. Line, '63, to Acting Executive Director of the Pension Benefit Guaranty Corp.

### **Obituaries**

### Thomas M. Hill, 1915-1977

Thomas M. Hill, a "down-easter" who had been a member of the M.I.T. faculty in the field of management and accounting for 31 years, died at the M.I.T. Infirmary on March 4 after a long illness. He was 62.

William F. Pounds, Dean of the Sloan School of Management, called Professor Hill "one of the most dedicated members of the Sloan School's faculty. . . . He had a substantial influence over the years on the development of some of the School's major programs," said Dean Pounds.

Professor Hill came to the M.I.T. faculty in 1946, having served in the Army during World War II. He had graduated from the University of Maine in 1936 and from Harvard Business School in 1938, after which he had taught accounting for two years at Yale and one year at Stanford.

For six years beginning in 1969 Professor Hill was Associate Dean for Administration at the Sloan School, and for two years beginning in 1961 he taught at the Indian Institute of Management, a key member of a team from the Sloan School developing the plans and organization for that new institution. Earlier he had held fellowships at Leeds University, England, and at the Institute of Basic Mathematics at Harvard; and in 1976 he was visiting scholar at the Administrative Staff College in Henley, England.

### Jeffrey L. Pressman, 1944-1977

Jeffrey L. Pressman, Associate Professor of Political Science who was one of the Institute's most popular teachers, died in Boston on March 1. He was 33, and his death was believed by authorities to be a suicide.

Professor Pressman was considered "the leading young scholar of American politics in this country," according to Professor Myron Weiner, Head of the Department of Political Science. But even more important, said Professor Weiner at a memorial service, "he engaged the intellect of our students — graduates and undergraduates. His concern with the lives of our students, both their intellectual and their personal lives, is legendary."

Professor Weiner's judgment was supported by an outpouring of tributes in the student press. Robert Kazdin, '76, wrote to *The Tech* that "Jeff Pressman was a great teacher, a good friend, and a great human being. No tribute high enough could be paid to this rare individual." And William Lasser, '78, Editor-in-Chief of *The Tech*, put it with simple understatement: "I knew Jeff Pressman well, as his student, as his advisee. I owe him a lot."

Professor Pressman studied at Yale (B.A. 1965), Oxford, and the University of California in Berkeley (M.A. 1967, Ph.D. 1972), and during his student days he was a legislative intern to Senator Lee Metcalf and later to Senator George McGovern. He came to M.I.T. in 1973 as Assistant Professor, after a one-year appointment in a similar post at Dartmouth.

Among Professor Pressman's major research interests were federal urban development programs, the politics of presidential nominations, the process of implementing policy in the American political system, and the role of the media in the American political process.

He was the author of six books and countless articles and was co-editor, for the M.I.T. Press, of a series on American politics and public policy.

### Deceased

Stanley G. Fitch, '00; February 25, 1977; 601 Summer St., Manchester, Mass.

Arthur E. Spencer, '05; September 15, 1969; 34 Elm St., Foxboro, Mass.

C. Ross Littig, '06; June 13, 1976; 2237 Wesley Ave., Evanston, III.

Arthur B. Appleton, '08; February 18, 1977; 11 Sherman St., Beverly, Mass.

Ralph J. Batchelder, '08; February 5, 1977; Apt. #711, 560 E. Villa St., Pasadena, Calif. George H. Magee, '10; September 5, 1975; 263 Harrell Dr., Spartenburg, S.C.

# Haley & Aldrich, Inc.

Consulting Geotechnical Engineers and Geologists

Soil and Rock Mechanics Engineering Geology Engineering Geophysics Foundation Engineering Terrain Evaluation

Harl P. Aldrich, Jr. '47 Martin C. Murphy '51 Edward B. Kinner '67 John P. Dugan '68 Douglas G. Gifford '71 Joseph J. Rixner '68

238 Main Street, Cambridge, Mass. 02142 617-492-6460

### Alexander Kusko, Inc.

Research, Development and Engineering Services in the Electrical Engineering Field

Specialties:
Electric power systems,
Electric transportation equipment,
Electric machinery and magnetics,
Solid-state motor drives, rectifiers, inverters,
Feedback control systems,
Computer applications and modeling,
Evaluation, investigation, patents.

Alexander Kusko '44 Wendell E. Phillips, Jr. '42 Trevor A. Creary '76

161 Highland Avenue Needham Heights, Mass. 02194 (617) 444-1381

### Polysciences, Inc.

Research, development, and consultation in the fields of polymers, monomers, life sciences, and medical plastics

B. David Halpern, '43

Paul Valley Industrial Park Warrington, Pennsylvania (North of Philadelphia) (215) 343-6484

# Stearns & Wheler

Civil and Sanitary Engineers Consulting Engineers

Sewerage Drainage and Flood Control, Water Supply and Distribution, Water and Waste Treatment, Municipal Engineering, Refuse Disposal,

W. O. Lynch '47, S. G. Brisbin, '50 A. G. Wheler '51, D. E. Schwinn '59

10 Albany Street, Cazenovia, New York 13035 (315) 655-8161

Chester Pepper, '11; February 6, 1977; 28 Edward C. Haines, '24; December 25, Lorena Rd., Winchester, Mass. George B. Brigham, '12; March 2, 1977; 517 Oxford Rd., Ann Arbor, Mich. Leon W. Parsons, '13; March 6, 1977; 45 Windsor Rd., New Britain, Conn. Mrs. Edward C. Wente, '14; December 14, 1976; 42 Colt Rd., Summit, N.J. Charles E. Woodlock, '14; October 11, 1971 Charles H. Calder, '15; December 23, 1976; Box 157, West Barnet, Vt. Joseph M. Livermore, '15; February 12, 1977; 116 Barker Rd., Oregon City, Ore. Eugene J. Barney, '16; January 9, 1977; Apt. 1004, 4600 Allen Dr., Allen Park, Mich. Marcel A. Gillis, '16; May 22, 1971 John B. Ingle, '16; February 28, 1975 Elmer M. Wanamaker, '16; January 22, 1977; Apt. 205, 100 The Esplanade, Venice, Frederick B. Philbrick, '18; December 10. 1976; 522 Miller Rd., Coral Gables, Fla. William J. Leahy, '19; March 8, 1977; 53 South Main St., Randolph, Mass. Harold F. Marshall, '19; November 22, 1976; 103 Morgan Ave., Palmyra, N.J. Elliot D. May, '19; January 12, 1977; 16 Academy St., Winchendon, Mass. Tsen F. Wei '20; May 15, 1975 Dugald C. Jackson, '21; March 17, 1977; 303 Darlington Rd., Havre De Grace, Md. Edward Sherman, '21; April 13, 1976 Robert H. Henderson, '23; January 26, 1977; 42 Stone Ridge Rd., Summit, N.J. Milton E. Parker, '23; February 8, 1977; R. R. 2, Box 105, Barrington, III.

1976; 50 E. Main St., Moorestown, N.J. Robert N. Vincent, '24; February 1, 1977; P.O. Box V, Teaticket, Mass. Hood Worthington, '24; February 14, 1977;

5-A Foulk Manor N., 1212 Foulk Rd., Wilmington, Del.

Henry C. Hoar, '25; February 27, 1977; 301 Indian Springs Rd., Williamsburg, Va. Raymond F. Taylor, '25; November 23, 1976; 25 Moury Ave., Union Village, Woon-

socket, R.I. Alan E. Cameron, '26; March 7, 1977; P.O. Box 748, Wolfville, N.S., Canada

O. William Freeman, '26; February 25, 1977; 216 Highway 31, Pennington, N.J. Neil H. Cargile, '27; December 30, 1976: 4524 Beacon Dr., Nashville, Tenn.

Henry K. Crowell, '27; January 19, 1977; 223 W. Gorgas Ln., Philadelphia, Penn. Gordon Jacoby, '27; April 1974

Albert Kauzmann, '27; February 6, 1977; 426 Wyoming Ave., Millburn, N.J. George W. Knight '27; May 11, 1968; 10461

S.W. 87th Pl., Miami, Fla. John T. McGillicuddy, Jr., '27; February 5,

Lenvik Ylvisaker, '27; October 25, 1976; 911 S.W. Tamarind Way, Boca Raton, Fla. Kenneth G. Russell, '29; March 16, 1977; 80 Inningwood Rd., Ossining, N.Y.

William H. Buracker, '30; March 8, 1977; 12 Stratford Rd., Winchester, Mass.

Philippe H. Bonnet, '31; March 12, 1977; 17 Beaumont St., Dorchester, Mass.

Arthur Lowery, '32; January 15, 1977; 20

Hemlock Dr., Holden, Mass.

Carl Alton McKinney, '32; February 26, 1977; 2136 Addison Rd., Houston, Tex. Charles O. Perpall, '32; August 3, 1976; Box 298, Hope, Idaho

William H. Brown, '33; November 5, 1976; 33 Woodland Rd., Auburndale, Mass. Robert W. Burton, '33; January 30, 1977; 7

Oliver St., New Castle, N.H. Ralph L. Garrett, '33; March 21, 1977; 235

Mt. Vernon St., West Newton, Mass. L. Preston Whorton, '35; January 2, 1977; 3615 Greenbriar Dr., Dallas, Tex.

Harold L. Smith, Jr., '39; March 14, 1977; 510 Oakridge Dr., Rochester, N.Y. Philip Darling, '40; March 17, 1977; 2005

Woodland Rd., Annapolis, Md. Joseph A. Bergantz, '41; June 5, 1976; 772

Forest Ave., Buffalo, N.Y. Hubert W. Dannevik, '48; February 2, 1977;

5871 Arboles St., San Diego, Cal. Anita P. Krause, '48; December 12, 1976;

47 11 Jayson Ave., Great Neck, N.Y. Arthur A. Werthmann, Jr., '61; January 18. 1977; 116 Twin Falls Rd., Berkeley Heights,

Frank M. Sadinoff, '63; March 30, 1976; 411 Alfred Ave., Teaneck, N.J.

Martin P. Kawich, '80; February 7, 1977; 189 River Rd., Bogota, N.J.

Correction: Norman Bruce Duffett, '40, is alive and well and living in Erie, Penn. His father, Norman Duffett, '11, of 151 Buffalo Ave., Niagara Falls, N.Y. died December 1, 1976.

### KULITE

### METALLURGY

Tungsten, molybdenum, cobalt, special alloys — fabrications. "HI-DENS" tungsten alloys - for counterweights and shielding.

### SOLID STATE SENSORS

Semiconductor strain gages, integral silicon force sensors and temperature sensors for measurement and control applications.

Anthony D. Kurtz, 1951 Ronald A. Kurtz, 1954

### KULITE

(Kulite Semiconductor Products, Inc., **Kulite Tungsten Corporation**) 1030 Hoyt Avenue, Ridgefield, N. J.

# albert

SUPPLIERS TO CONTRACTORS GENERAL/MECHANICAL/ELECTRICAL/ PILING/MARINE

SUPPLIERS TO INDUSTRY MINING/PETROLEUM/CHEMICAL/ UTILITIES/NUCLEAR POWER/ECOLOGY

### MANUFACTURERS • FABRICATORS • DISTRIBUTORS

- PIPE VALVES FITTINGS IN STEEL

- PRESSURE VESSELS & LARGE DIA. PIPE

- STAINLESS ALLOY ALUMINUM
   YOLOY PLASTIC FIBERGLASS
   ASBESTOS CEMENT BRASS COPPER
   "SPEED LAY" PIPE SYSTEMS STEEL/ ALUMINUM

WITH TRACEABILITY DOCUMENTATION, INSTITUTED THROUGH A RIGID QUALITY ASSURANCE PROGRAM

AND NOW ONE OF THE MOST COMPLETE STAINLESS STEEL INVENTORIES IN THE UNITED STATES INCLUDING ALL ALLOYS!

FOR WORLD WIDE EXPORT ALBERT INTERNATIONAL CORPORATION

Cable: "ALBERTINCO NEWYORK" Telex: RCA 233573 - "ALB UR" WUD 12-6348 - "ALBERTCO NYK"

Telex: WUI 62140 - "ALBINT"

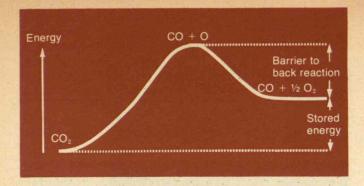
WRITE FOR FREE BROCHURE:



PIPE SUPPLY CO., INC.

101 VARICK AVE., BROOKLYN, N.Y. 11237 Telephone: [212] 497-4900

S.G. ALBERT '31 . A.E. ALBERT '56



The conversion of carbon dioxide to carbon monoxide and molecular oxygen. The reaction products will not reconvert to the original compound, for doing so requires that an energy barrier be surmounted. Thus a part of the energy added to the system is stored in the reaction products.

Energy  $Fe(CN)_6^{3-} + e^-$ Back reaction  $Fe(CN)_6^{4-}$ 

The conversion of Fe (CN)  $_6{}^{4-}$  to a high-energy pair: Fe(CN)  $_6{}^{3-}$  and a free electron. These endproducts have a short life, for there is no barrier to their back reaction.

trolyzed; at peak demand the electrochemically generated H<sub>2</sub> and O<sub>2</sub> could be recombined.

Of course, electrical energy input is required to convert  $H_2O$  to  $H_2$  and  $O_2$ : specifically the power supply must provide a potential difference of at least 1.23 volts between the two electrodes before any current flows in concert with the electrolysis of  $H_2O$ . This is the thermodynamic limit. Generally, even for the best electrodes, one needs to provide a potential difference of at least 1.5 volts to observe sustained electrolysis at a good rate. The point here is that it is not sufficient to put just any potential between the two electrodes. The electrolysis of  $H_2O$  represents an electrical load, but unlike a simple resistor, the electrochemistry is such that no current flows unless the applied potential exceeds the thermodynamic minimum of 1.23 volts.

Now the thermodynamic minimum necessary for current flow is a function of the cathode and anode reactions. In some cases, current may flow with the application of a very small potential. Consider these hypothetical redox processes:

A 
$$\longrightarrow$$
 A<sup>+</sup> + e<sup>-</sup> (anode process)  
A<sup>+</sup> + e<sup>-</sup>  $\longrightarrow$  A (cathode process)

In principle, one can pass electric current through an electrolyte containing A and A<sup>+</sup> without any net chemical change: what happens at the cathode is reversed at the anode. The only resistances to the flow of current are those associated with small barriers to the electron transfer and with the fact that no electrolytes and wires are perfect conductors.

It has been known for over a hundred years that by shining light on electrodes one can induce a flow of electric current without having to apply any potential at all. Knowing that the current flow must nevertheless be accompanied by redox processes, it is thus possible to image a photoelectrochemical cell to convert the incident light energy into chemical fuels (in the form of electrolytic products), and also into electricity, because current flows in the external circuit. A photoelectrochemical cell is shown on page 30.

As might be guessed, a key feature of the photoelectrochemical cell is the photoelectrode. The ones fabricated from materials known as semiconductors have been found to give the largest photocurrents for a given light intensity, but a difficulty has been encountered in their use: for almost every efficient photoanode the photoredox process occurring at the electrode is the irreversible decomposition of the semiconductor. As an example, cadmium telluride (CdTe) photoanodes undergo the following decomposition:

$$CdTe - 2e^- \rightarrow Cd^{2+} + Te$$

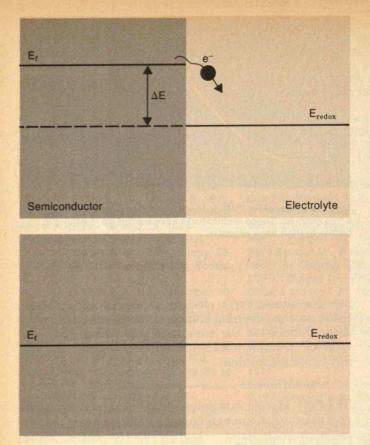
The Cd<sup>2+</sup> ions go into solution and elemental tellurium (Te) is formed. Current flow still obtains, but only as long as the electrode lasts!

In 1976, three independent research groups reported on the photoelectrolysis of H<sub>2</sub>O to H<sub>2</sub> and O<sub>2</sub> using a strontium titanate (SrTiO<sub>3</sub>) photoanode-based cell. Their results followed earlier findings that certain semiconducting metal-oxide photoelectrodes were inherently stable. The SrTiO<sub>3</sub>-based cell was demonstrated in the laboratory to have light-to-chemical-energy conversion efficiency rivaling that of any man-contrived photochemical conversion device, and estimates show that such a photoelectrolytic cell can produce fuel with an efficiency close to that of schemes exploiting plant photosynthesis. These remarkable developments have stimulated work in over thirty independent research groups all over the world.

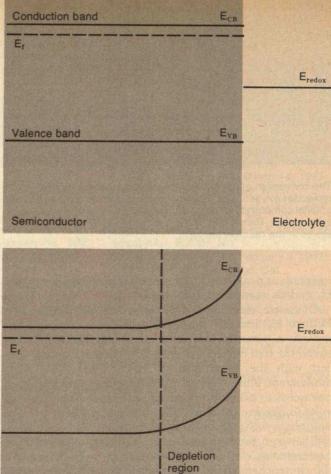
A second result was reported in 1976. Research carried out in my laboratory showed that CdTe photoanodes (and other inherently unstable photoanodes) could be stabilized in aqueous electrolytes containing redox-active species of the type A/A+ mentioned above. This result is valuable because SrTiO<sub>3</sub> photoanodes respond only to the ultraviolet rays of the sun — a fraction of the sun's energy equalling only three per cent of the total — whereas CdTe photoanodes respond to over fifty per cent of the sun's output. This value comes close to that obtaining for the best photovoltaics. The stabilized CdTe could not, however, be used to drive the electrolysis of H<sub>2</sub>O. Rather, the redox-active A/A+ in solution allowed the transfer of electrons, leading to an output of electricity.

The discovery of stable photoelectrodes and the stabilization of sunlight-responsive electrodes has justifiably sparked interest in photoelectrochemical cells. Continued progress will likely result from a basic study of photoassisted interfacial processes.

Semiconductor Photoelectrodes: Elements for Success Let us now examine the mechanism of photoinduced electrolyses using semiconductor electrodes. Generally, it is



A semiconductor comes to equilibrium with the electrolyte in which it has been placed. Before equilibration (top drawing) the chemical potential — that is, the energy required to remove electrons — is different for the two materials. Accordingly, electrons move from the semiconductor to the electrolyte until the two potentials are equal (bottom drawing). In this figure, and the two similar figures that follow, the horizontal dimension represents length, but the vertical dimension represents energy.



Further details of the electronic events that are involved as a semiconductor comes to equilibrium with an electrolyte. Again the vertical dimension measures energy while the horizontal measures length. Broadly speaking, electrons in the semiconductor have either of two energies: they are said to occupy a valence band or a higher-energy conduction band. After equilibration, both bands bend downward in energy beneath the surface of the semiconductor — a consequence of the transfer of electrons shown in the preceeding illustration.

the light-induced changes in the distribution of electrons in a material that give rise to photoinduced reactions. What is unique about semiconductors is that there exists a mechanism for inhibiting the recombination of photoseparated positive and negative charges.

To understand the significance of this feature, consider the following reaction:

Fe 
$$(CN)_6^{4-}$$
  $\longrightarrow$  Fe  $(CN)_6^{3-}$  +  $e^-$ 

which occurs according to the scheme shown on page 33. Obviously, the high-energy pair Fe(CN)<sub>6</sub><sup>3-</sup>, e<sup>-</sup> will relax immediately to the original Fe (CN)<sub>6</sub><sup>4-</sup> unless a barrier to the back reaction is introduced. The semiconductor introduces such a barrier when it comes into equilibrium with the electrolyte. By this we mean that at equilibrium there is no longer any driving force for net charge-transfer from semiconductor to the electrolyte or vice versa. In other words, the *chemical potential* of the electrons in the semiconductor matches the chemical potential of the electrons in the electrolyte, where the chemical potential of the electrons is a measure of the energy required to completely remove them from the material. Consider the

sketch at the left above. Before equilibration, the chemical potential of the semiconductor,  $E_f$ , and that of the electrolyte,  $E_{\rm redox}$ , are different by an amount  $\Delta E_f$ , as shown in the top part of the illustration. But by the transfer of electrons, the value of  $E_f$  and  $E_{\rm redox}$  can be matched, as shown in the bottom part.

Now the energy levels available to the electrons in a semiconductor are called bands. The valence band represents a set of levels at energy EVB that are filled with electrons. The conduction band represents a second set of levels at higher energy, ECB. For a certain class of semiconductors (those called n-type), a number of electrons occupy the conduction band, and these are the charge carriers that give rise to semiconductivity. The position of E<sub>f</sub> for n-type materials can be just below the E<sub>CB</sub> level, as sketched in the top part of the illustration directly above; and that part of the illustration represents the situation prevailing before the semiconductor comes to equilibrium with the electrolyte. After equilibration, however, we find that an important change has occurred in the energy levels of electrons within the semiconductor (see the bottom part of the illustration). The E<sub>CB</sub> and E<sub>VB</sub> positions remain fixed relative to E<sub>redox</sub> at the interface between electrolyte and semiconductor. But within the bulk of the semiconductor, the energy of electrons declines. This is understandable in the following way. In equilibrating the E<sub>f</sub> and E<sub>redox</sub> values, some electrons have been transferred from the semiconductor to the electrolyte, tending to make the electrolyte negatively charged. From now on, bringing an electron from the bulk of the semiconductor toward the electrolyte will require energy, since like charges repel one another. Thus, electrons in the semiconductor conduction band will tend to move away from the surface, creating a region near the surface that is depleted of the charge carriers. The "band-bending" region is therefore also termed a depletion region.

Band bending is the phenomenon that creates a barrier to charge recombination. This happens in the following way: the valence band and the conduction band are separated by an energy EBG, called the band gap. Accordingly, illumination of the semiconductor with light of energy greater than EBG can excite electrons from the completely-filled valence band to the partially-filled conduction band, as shown in part A of the illustration at the right. The removal of an electron from the valence band leaves behind a positive hole, designated h+. Since the h+ position may not be at the electrode/electrolyte interface, it represents a stable position for a valence-band electron closer to the semiconductor's surface. Such an electron will fill the photogenerated h<sup>+</sup>, and the h<sup>+</sup> correspondingly will rise toward the surface. As for the excited e, it, as we explained in the last paragraph, will move into the bulk of the semiconductor. The result is charge separation: in both the conduction and valence bands, holes move to the semiconductor's surface and electrons into its bulk (see part B of the illustration).

The h<sup>+</sup> at the semiconductor surface could, of course, be filled by electrons from the electrolyte. There is thus a tendency for the electrolyte to give up an electron to fill the h<sup>+</sup>, and for the electrolyte itself to be oxidized. The oxidation of the electrolyte can be written as follows:

$$A + h^+ \longrightarrow A^+$$

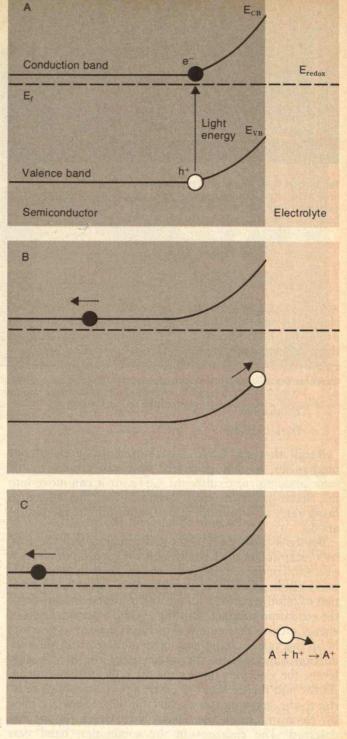
In essence, the positive hole moves into the electrolyte, and an electron into the semiconductor. Back reaction of  $A^+$  and an electron is prevented by the band-bending barrier. That is, the electron is driven into the bulk of the semiconductor; to recombine with  $A^+$  it would have to go "uphill" over the barrier of  $\Delta E$ . Ultimately, to complete the external circuit shown on page 30, the electron is deposited into the electrolyte from the cathode according to the following reaction:

Thus, the net reaction is the light-induced oxidation of A and reduction of B:

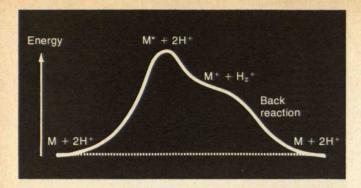
$$A + B \longrightarrow A^+ + B^-$$

If the species oxidized is OH<sup>-</sup> (to evolve O<sub>2</sub> gas) and if the species reduced is H<sup>+</sup> (to evolve H<sub>2</sub> gas), then the products can easily be separated to prevent back reaction. Such is the case in SrTiO<sub>3</sub>-based cells, where O<sub>2</sub> is evolved at the SrTiO<sub>3</sub> anode and H<sub>2</sub> at the cathode in the photoelectrolysis of H<sub>2</sub>O.

If, however, the objective is only to produce electricity, then the back reaction of A<sup>+</sup> and B<sup>-</sup> would be desirable, for it would preclude any net chemical change in the electrolyte. As it happens, the reactions in a CdTe-based cell are even better: here, the oxidation product at the CdTe



The creation of electric current when light is shone on a photoelectrode immersed in an electrolyte. In (a), incident light provides sufficient energy to "raise" an electron from the valence to the conduction band; a positively-charged "hole" is left behind in the valence band. This hole will be occupied by electrons closer to the semiconductor's surface, and in this way will "move" closer to the electrolyte. Meanwhile, the high-energy electron will be driven deeper into the semiconductor by repulsive forces (b); recall that the electrolyte gained negative charge during equilibration. Finally, the hole will move into the electrolyte, and the high-energy electron will move into the external circuit (c). Back-reaction — in this case, movement of the electrons and holes in directions opposite to those shown in the illustration — is prevented by the band-bending.



An attempt to use light for the direct creation of high-energy materials. Here, it turns certain metal complexes, M, into the excited complexes, M\*. However, there is no barrier to back-reaction, and thus no energy is stored.

anode is reduced at the cathode to regenerate the original electrolyte species. Accordingly, no energy is wasted into producing high energy A<sup>+</sup>, B<sup>-</sup> products, only to have them recombine to release their energy. The reactions employed in the CdTe-based cell are represented by redox chemistry in these two reactions:

Photoanode: A 
$$\xrightarrow{\text{light}}$$
 A<sup>+</sup> + e<sup>-</sup>  $\xrightarrow{\text{Photoanode:}}$  A

Dark Cathode: A<sup>+</sup> + e<sup>-</sup>  $\xrightarrow{\text{Photoanode:}}$  A

Recall that the CdTe is stabilized. In terms of our mechanism, a photogenerated hole can remain in the semiconductor to oxidize the CdTe, or it can move into the electrolyte to make A<sup>+</sup>. Here it does the latter at a faster rate, thus precluding decomposition of the photoanode.

Before assessing efficiency, advantages, and the like, let's recapitulate the key elements for success: Immersion of a semiconductor electrode into an electrolyte results in band-bending, which creates a barrier to the recombination of photoseparated charge and to the back-reaction of the oxidation product with the excited electron. Light of energy greater than or equal to EBG is needed to generate h+ in the valence band and excited electrons in the conduction band. Under the influence of the bent energy levels, the electrons move into the bulk of the semiconductor and thence into the external circuit, while the h+ rise to the semiconductor's surface, where they are filled by electrons from the electrolyte, which is thereby oxidized. The electrons in the conduction band pass through the external circuit and return to the electrolyte at the cathode, where they reduce some component of the electrolyte solution. Naturally, the durability of both the electrode and the electrolyte systems is crucial to the development of useful devices. In fact, it is at present the key question.

### Photoelectrochemical Cells: Efficiency and Advantages

The energy output of a semiconductor-based photoelectrochemical cell is related to the amount of band bending. Indeed, the total energy output (stored chemical energy plus electrical energy) can be only as great as the band bending,  $\Delta E$ , for  $\Delta E$  is the net voltage drop experienced by an electron as it passes through the entire circuit. Therefore, since light of energy greater than or equal to

E<sub>BG</sub> is required to start the circuit working, the maximum energy conversion efficiency, n<sub>max</sub>, is given by the following equation (assuming light of a single energy):

$$n_{\text{max}} \leq \frac{\Delta E}{E_{\text{BG}}}$$

Thus, for a given semiconductor, we seek a  $\Delta E$  approaching  $E_{BG}$ . If  $\Delta E$  were greater than  $E_{BG}$  the semiconductor could spontaneously, irreversibly, decompose in the dark!

Plainly, optimizing  $\Delta E$  is crucial.

In order to determine an actual solar energy conversion efficiency, two facts must be considered: sunlight is not of a single energy, and light of energy greater than  $E_{BG}$  is no more effective than light equal to  $E_{BG}$ . These facts lead to the conclusion that there exists an optimum  $E_{BG}$ , corresponding to the most efficient use of sunlight. This optimum is about 1.1 electron volts (eV). For SRTiO<sub>3</sub> the  $E_{BG}$  is 3.2eV — far too high. For CDTe, however, the  $E_{BG}$  is 1.4eV — close to ideal. If  $\Delta E$  were close to  $E_{BG}$  for CdTe, the maximum solar energy conversion efficiency would be 45 per cent. Results in my laboratory so far show a  $\Delta E$  of only about 0.7V in stabilized situations, and an overall conversion efficiency (solar to electrical energy) of only about 5 per cent. There is considerable room for improvement.

The important point, however, is that the theoretical efficiency of photoelectrochemical cells is equal to that of the photovoltaic devices used in satellites and the like. Moreover, several potential advantages exist for the photoelectrochemical cells. Most important, perhaps, is the advantage that a single photoelectrochemical cell can store light energy in the form of conventional fuels and also convert light to electricity. There is even the prospect of varying the proportions: within the constraint that the total energy output is  $\Delta E$ , one should be able to vary the output of a single cell from 100 per cent electrical to 100 per cent storable chemical fuels.

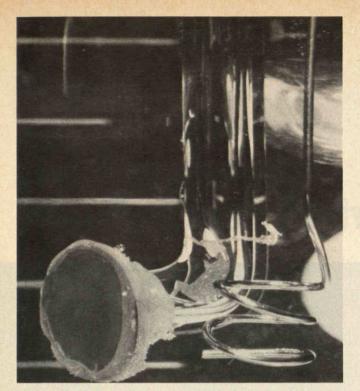
A second advantage concerns the ease with which the device can be fabricated. Band-bending in a photoelectrochemical cell is trivially introduced by immersing the electrode into a liquid electrolyte. By contrast, the creation of a comparable effect in photovoltaics depends on the careful construction of a solid-solid junction. Furthermore, the band-bending in a semiconductor exposed to a liquid can be varied simply by changing the electrolyte. Thus the chemist has a wide range of ways to introduce design changes at the molecular level.

A third advantage is that photovoltaics employing a solid-solid junction have problems associated with differences in the thermal expansions of the two solids, for the differential expansion tends to destroy the quality of the junction. Obviously, the solid-liquid junction is not plagued by this difficulty.

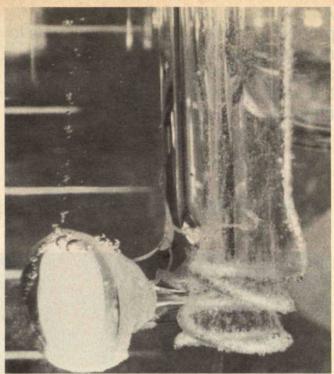
A fourth advantage: solid-state photocells often require anti-reflection coatings to boost the amount of light actually absorbed. For the liquid-junction cells, this factor could be minimal: the liquid itself could play the role of

the anti-reflection coating.

Semiconductor photoelectrochemistry can also have an advantage compared to purely photochemical systems for conversion of light to electricity and to high-energy materials. For example, irradiation of certain metal complexes, M, in solution results in the creation of excited complexes, M\*, which are energetically capable of reducing H+ ions to form H<sub>2</sub> molecules. One difficulty is that the primary redox products may back-react. Consider the reaction sequence:



The use of a light-sensitive semiconductor electrode to induce the electrolysis of water. In each photograph, the electrode at the left is strontium titanate (SrTiO<sub>3</sub>); the one at the right is coiled metal wire. Both are immersed in water. In the second of the two photographs, intense light plays upon the SrTiO3 electrode. Now an electric



current flows, and water is decomposed. The gas evolving from the semiconductor electrode is oxygen; the gas evolving from the coiled wire is hydrogen. The photographs were taken by Bruce A. Parkinson.

$$M + 2H^{+} \xrightarrow{light} M^{*} + 2H^{+}$$

$$M^{*} + 2H^{+} \longrightarrow H_{2}^{+} + M^{+}$$

$$M^{+} + H_{2}^{+} \longrightarrow M^{+} + 2H^{+}$$

Here, the first reaction is the creation of M\*. The second reaction produces only the intermediate product H<sub>2</sub><sup>+</sup>; still another reduction would be necessary to produce H<sub>2</sub>. Unfortunately, the intermediate product is capable of backreacting with the oxidized complex, M+ (third reaction; the overall energetics are shown on page 36). Thus, an otherwise useful photochemistry is thwarted by back reaction of the high-energy intermediates. With semiconductor electrodes, as we noted, there is a barrier to back reaction, and at the same time the mechanism is such that low-energy photons can be used: it is possible to photoelectrolyze H2O with visible light.

In conclusion, semiconductor-based photoelectrochemical cells offer some real advantages in the conversion of sunlight to fuels and to electricity. Continued basic research is needed to understand the photoelectrochemical process. It is my view that our efforts will best be placed in determining the factors that control interfacial electron transfer rates, and in manipulating such rates. It is too early to make a safe forecast. Still, the demonstrated laboratory efficiencies have stimulated considerable activity in industries, governments, research institutes, and universities all over the world. The best man-contrived photochemical conversion systems are presently the photoelectrochemical cells, and significant future potential exists.

Looking ahead to the day when technical feasibility is realized, one can expect that the photogeneration of fuels and electricity by chemical-based systems will find wide application (fuel generation for transportation seems especially needed). Technical complexity may restrict the homesite installation of such systems. Accordingly, large-scale stations will more likely be the future of photochemical systems for the utilization of sunlight.

### References

M. S. Wrighton, A. B. Ellis, P. T. Wolczanski, D. L. Morse, H. B. Abrahamson, and D. S. Ginley, Journal of the American Chemical Society, 98 2774 (1976).

T. Watanabe, A. Fujishima, and K. Honda, Bulletin of the Chemical Society of Japan, 49, 355 (1976).

J. G. Mavroides, J. A. Kafalas, and D. F. Kolesar, Applied Physics Letters; 28; 241 (1976). A. B. Ellis, S. W. Kaiser, and M. S. Wrighton, Journal of the American

Chemical Society, 98, 6418, 1635, 6855 (1976). H. Gerischer, Journal of Electroanalytical Chemistry, 58, 263 (1975).

G. Hodes, J. Manassen, and D. Cahen, Nature, 261, 403 (1976).

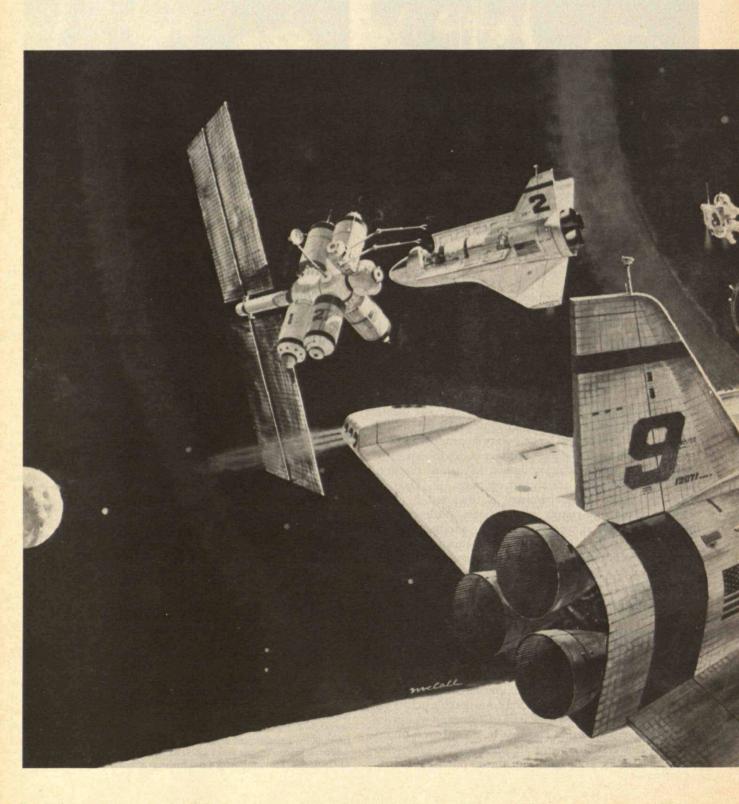
B. Miller and A. Heller, Nature, 262, 680 (1976). D. L. Laser and A. J. Bard, Journal of the Electrochemical Society,

123, 1027 (1976). K. L. Hardee and A. J. Bard, ibid., 124, 215 (1977).

J. M. Bolts and M. S. Wrighton, Journal of Physical Chemisty, 80, 2641 (1976).

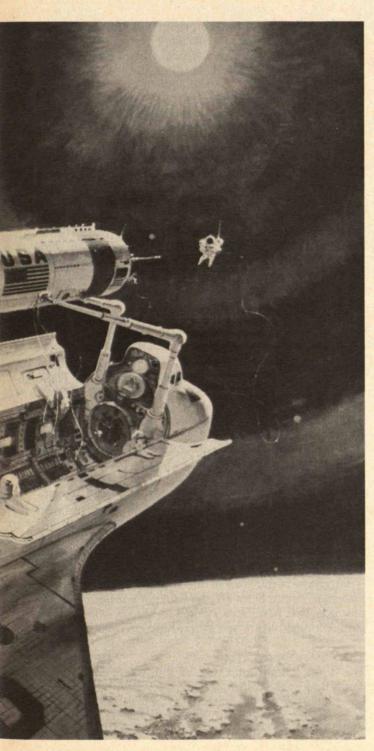
Mark S. Wrighton received his B.S. in chemistry from Florida State University and his Ph.D. in chemistry from the California Institute of Technology. At Caltech he was named the first recipient of the Herbert Newby McCoy Award. In 1972 he joined the faculty of M.I.T. as Assistant Professor of Chemistry; in 1976 he was named Associate Professor; and his appointment to the rank of Professor becomes effective on July first. In the first quarter of 1977, he held the Standard Oil Company of California Visiting Energy Professorship at Caltech.

An enormous range of commercial products, from electronic components to medicines, could be manufactured in space. The economics look promising, but some hard-nosed research will be needed.



Donald M. Waltz Space Vehicles Division TRW. Defense and Space Systems Group

# The Promise of the Space Factory



The possibility of industrializing outer space is one of the most exciting concepts of the U.S. space program. Until now, our efforts in space have focused on scientific research, exploration, and support of military needs. With firm success in these areas, we are now ready to consider the prospects of practical space industrialization. The word itself - industrialization - denotes a new vista of thinking for space projects. To discuss industrialization, we must use terms such as production of goods and services, manufacturing equipment, labor force, competition, return on investment, products and markets and risk. These terms are well known to earth businessmen, but for space planners they portend a new way of looking at future projects.

Among suggested space industries are electric power stations in space that would supply earth; public service platforms for communications; and space factories to make unique products and materials for earth or orbital use. These are, of course, in addition to satellites providing weather services, earth resources surveys, navigation services, and the relay of educational and entertainment programs.

Advantages of the Space Factory

The new and cheaper products to be manufactured in space will be primarily those that can benefit from the lack of gravity. With the exception of weightlessness, all other characteristics of the space environment, such as high vacuum and radiation, can be achieved on earth.

Weightlessness, or gravities less than earth-normal, however, can be produced on earth only by free-fall, and these conditions can be achieved for only about 20 to 30 seconds, for instance in an airplane flying a specific trajectory. At present only a very few manufacturing processes with very short processing cycles exploit less-than-natural

One major benefit of such low-gravity processing would be that materials to be processed could be "levitated," suspended in mid-air without touching a container. In the low-gravity environment only small forces, such as electromagnetic, electrostatic or acoustic fields would be needed to control the position of relatively large amounts of material. These fields would be low enough

A space factory of the 1990s is constructed using modules carried into orbit by the Space Shuttle. Such factories, using semi-automated equipment, could manufacture a wide range of products for use in space and on earth. (Illustration: N.A.S.A.)

### **Electronic Products**

Semiconductors Integrated circuit chips Magnetic switches

Relays

Magnetic detectors

Ultrasonic and optical frequency

Superconductors High-power rectifiers Ferroelectrics Radiation detectors X-ray targets

Holographic storage crystals Piezoelectric light-emitting

### **Optical Products**

Narrow band filters Large diameter crystals Uniformly doped crystals Selected wavelength opticals Supporting optics for laser

High index of refraction glasses

Improved fiber optics Ceramic waveguides Holographic storage devices Infrared transmitting glasses Lenses and mirrors with advanced performance

In just the first few studies of the possibilities of space manufacture, a wide variety of candidate products has already been identified.

that the material, such as a melted solid, would not be seriously disrupted, for instance, by overheating. Since there would be no need for containers in space factories, there would be no danger of impurities from containers entering the material — a major problem in earth-manufacture of highly reactive, high-melting-point materials. For instance, crucible contamination is probably the most serious limitation in producing highly purified glass for lasers and laser system optics, and it seriously hinders the ability to grow pure crystals for semiconductors.

Containerless processing would also eliminate the container's surface irregularities which contact the melted material. These irregularities provide sites for undesirable crystal growth in a solidifying liquid, which spoils the perfection of the solid. Finally, containerless processing would allow more flexible heating arrangements for melting solids, for instance allowing heating to be focused on

a certain part of a melted sample.

A second major advantage of low-gravity processing is the elimination of "gravity-induced convection" in liquids. A melted material will always contain regions of different temperature and, thus, different density. On earth, gravity's pull on these regions causes convections which spoil the homogeneity of a liquid. Weightless processing will also eliminate the separation of ingredients in a mixture due to their differing densities. A reduction in convection currents will allow much better control of heat and mass transport in liquids and gases. Many processes in which buoyancy and thermal-convection cause problems will change drastically in the weightless or lowgravity space. For instance space manufacturers will find it easier to deposit materials on surfaces, mix and homogenize liquids, polymerize chemical components, separate and purify components of mixtures, cast mixtures of metals and, as I've already indicated, grow crystals.

In weightless space, molecular forces like cohesion and adhesion will replace gravity as the strongest environmental forces. They will thus become the factors that control processes, and there will be drastic changes in various kinds of casting and drawing processes.

A Plethora of Space Products

In a few early studies of applications for space-processed materials we have already compiled a wide variety of electronic, optical, biological, and structural uses for space products (see above). Of course, the decision to produce these or other potential products still awaits early answers to scientific, engineering and business/legal questions. But even if some products do not prove out, potential space products are so numerous and diverse that the chances are good that space processing will yield many economic and social benefits to both the public and industry.

So far only limited experiments on gravity-free processing have been conducted — in the Apollo, Skylab, and joint Apollo/Soyuz Test Project flights. However, with the onset of the Space Shuttle and Spacelab in the early 1980s we can expect verification of basic theory, the discovery of new space-produced materials and limited product processing. Still further along, we can foresee pilot plant operations by the mid-1980s and commercial production in the 1990s.

Past experimental results and N.A.S.A.'s plans for future research suggest that initial commercial space ventures will probably involve the production of electrical materials, glasses, and the separation of biological sub-

Space-manufactured electrical materials will consist mainly of monocrystalline semi-conductors, whose electrical properties are enhanced by higher purity, homogeneity, and structural perfection — the same improvements demonstrated as the result of crystal-growth experiments on Skylab and the Apollo/Soyuz missions. These materials form the basis for all integrated-circuit technology, and the future market for them will be enormous. Space factories could also produce glasses of very high purity and optical homogeneity, which could be used in high-resolution optics, high-power laser systems, and low-loss fiber-optic transmission lines. There might also be profit in the large-scale processing of biological materials in space, where weightlessness would allow easy separation of components. A number of pharmaceutical companies are interested in space production of drugs; however, the saving of lives and alleviation of human suffering could easily dwarf the profit potential as an incen-

To give a better idea of the specific findings of space materials research so far, let us examine four specific products that have been studied — silicon ribbon, laser glasses, optical fibers and therapeutic enzymes.

The Perfect Space Crystal

The single-crystal silicon used for integrated circuits could be produced in much greater yield in gravity-free space because of the absence of convection. A recent analysis by McDonnell Douglas Astronautics Co. (M.D.A.C.) showed that yields in the manufacture of typ-

### **Biological Products**

Human cell purification

High-purity biologicals for use in making vaccines

Enzyme isolation (production of urokinase)

Differentiation, isolation, and culture of white blood cells (lymphocytes)

Immunoglobulin production

Protein purification and production

Hormones production (erythropoietin)

Differentiation among and isolation of fractions of red blood cells (erythrocytes)

### Structural Uses

Better turbine blade materials
Low-failure-rate materials
Longer lifetime materials
Improved lubricants
Stronger materials with low

Stronger materials with low erosion rates for special application, incl. pins for bone setting High-strength composites
Better surface materials
High-purity materials
Better nuclear fuel rods
Detector materials with better
sensitivity and longer carrier
lifetimes

ical integrated circuits could be increased in the environment of space — from the present-day 21 per cent using wafers cut from a larger mass to 35 per cent using space-processed silicon ribbon, and that a crystal producer could make a substantial return on investment.

The M.D.A.C. investment analysis showed a potential 30-per-cent rate of return for a factory investment satisfying only 5 per cent of the projected 1985 market. The integrated circuit manufacturer could pay as much as four times the current cost of earth-produced wafers or chips and still increase his profits by 20 per cent, because of the increased yield in number of usable wafers per unit mass of silicon produced. Or, the manufacturer could lower his price, capture a larger share of the market and still increase his profits. Because of the higher yields from the raw materials, he has actually an excess capacity if his market share remains constant. This excess capacity can readily be put to use to increase market share by reducing prices. Clearly he has great flexibility in the amount of ribbon to market, not to mention the potential improvements in material quality from gravity-free processing. However, without experimental results we can only speculate what these improvements might be.

In its economic analysis, the M.D.A.C. researchers assumed the use of an automated method of space-producing silicon ribbon (see page 46). In this process, the high quality of the ribbon depends on containerless non-contact processing of the melt in micro-gravity and electromagnetic coils to shape the ribbon as it is pulled from the melt. The heat required for maintaining the melt is supplied by a solar furnace.

The automated silicon ribbon process can also be modified for the automated production of solar cell ribbon in space, said the M.D.A.C. report. This raises another possible space industry — the production from silicon ribbon of solar cells for converting sunlight into electricity.

It has been proposed that a considerable portion of our energy needs could be met by orbiting solar power stations, which beam their collected power via microwaves to receivers on earth. Such stations unlike earthbased solar arrays could remain in sunlight almost constantly.

Space-produced solar cells would almost certainly be of higher quality than those produced on earth and, thus, more efficient at converting sunlight into electricity. This higher efficiency would mean savings in the required size of an orbital (or earth-based) solar station, in its supporting structure, and in construction costs. According to the M.D.A.C. calculations, ten silicon-ribbon-processing machines deployed in a dedicated space facility could

produce enough solar cells each year to build a 23-megawatt solar power station. (Ten processors would be the limit of one Space Shuttle cargo bay delivery capacity.) The yearly solar cell output of seven plants could then be assembled into solar array blankets in a manned space station facility.

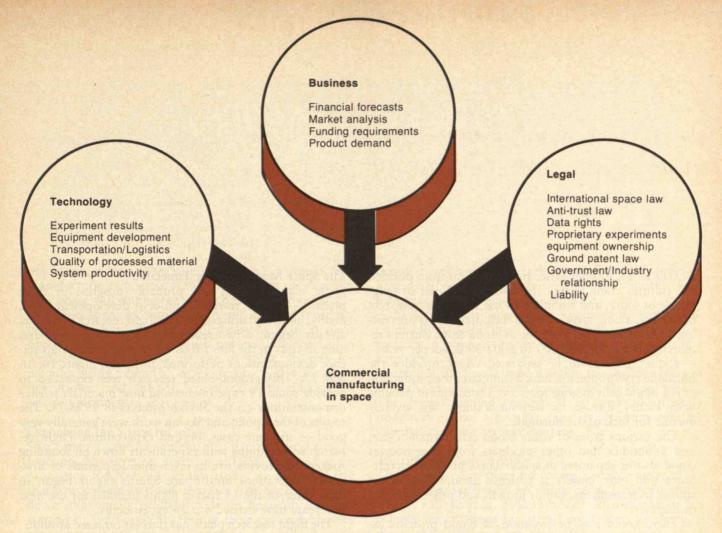
### Clear Laser Glass and Purer Glass Fibers

Owens-Illinois, Inc., under contract to the Jet Propulsion Laboratory has performed a study which demonstrated that improved lasing glasses could theoretically be prepared in space by increasing the calcium oxide content of the commercial glasses currently marketed by Owens-Illinois. The Owens-Illinois researchers showed, for example, that increasing the content from 20 to 30 per cent would increase the lasing efficiency by about 10 per cent. It is infeasible to make such high-quality improved glasses on earth because an increase in CaO content also increases the tendency of the glasses to "devitrify," or crystallize inhomogenously. Such devitrification occurs quite readily on the container walls and on impurities from the walls. So, containerless processing in space should eliminate or at least greatly reduce formation of crystal nuclei, reducing devitrification.

The Owens-Illinois study was devoted mainly to calculating the nucleation and crystal growth characteristic of the conditions of a space laboratory. The researchers concluded that in the absence of heterogeneous nucleating sites experimental laser glass material may be readily formed crystal-free. The Owens-Illinois group also performed a number of fundamental physical studies of the phase behavior of the glass system, and found no basic theoretical problems with the glass components separating out under weightless conditions. Interestingly, the group conducted a "splat-cooling" experiment in which the glass is cooled extremely rapidly as it falls freely from a container. They found that, although small crystallites invariably marred the material's surface, the interior was crystal-free. This result showed that earth fabrication of this material will always be marred by crystallization due to surface contact, regardless of the cooling rate. Yet, it also indicated that in principle one could spacemanufacture this material in bulk crystal free.

The Owens-Illinois researchers reported that a small increase in laser efficiency could produce a sizeable cost reduction in the U.S. laser fusion program. Furthermore, they concluded that creating more efficient glass lasers could open up new untapped markets for this product. Glass fiber channels, or similar "light pipes," now under

### Containerless Processing **Facility Research Furnace Facility Research** categories include: categories include: Homogeneous nucleation Hetrogeneous nucleation studies in glasses in glasses Containerless shaping Complex glass formation of lenses 3 Directional solidification Preparation of oxideof ceramic compositions free glasses Crystal growth by chemical Crystal growth from melts vapor transport 5 Contaminant-free, complex Bridgman crystal growth glasses Flux crystal growth Amorphous ferromagnetic Liquid phase sintering materials 8 Controlled solidification Bubble fining in molten Molten zones in microviscous fluids gravity Zone refining Directional solidification Czochralski crystal growth Coating by evaporation/ 10 condensation **Core Facility** Description: This facility contains apparatus necessary to provide power, cooling, fluids, control and data acquisition services to the processing facilities Principal subsystems: Power conditioning Thermal control Fluid supply Data acquisition Process control Chem/Fluid Processing **Facility Research** categories include: Surface tension driven **Biological Processing Facility Research** convection phenomena Droplet coalescence studies categories include: Bubble nucleation studies Dialysis Thermal diffusion controlled Electrophoretic separation separation studies of cells, serums, proteins, etc. Multiphase fluid phenomena Growth of bacterial cultures Flocculation studies in 4 Lyophilization polymers Isotachophoretic separation Emulsion polymerization of biological material phenomena Growth of biological cells Electrolysis reaction studies in low-G Particulate generation from chemical reactions 10 Solution crystallization studies



Left: The Spacelab missions to be flown on board the Shuttle in the 1980s will be organized according to payload category. One or more of these payloads will be flown on each mission, with the core payload an integral part of all missions.

ble. If space-produced fibers of 1 db/km could be produced this would mean a repeater only about every 20

Above: Profiting from space manufacturing will mean first

answering questions in a broad range of areas, besides

development are potentially capable of carrying a prodigious volume of information. Operating at the frequency of visible light or in the infrared spectrum, a single optical channel should be able to carry millions of voice signals or thousands of television signals. Optical fiber transmission, using a laser light or light-emitting diode light source, could lead to new kinds of underground and submarine cables with virtually unlimited capacity. The performance of optical fibers is very dependent on their light attenuation per unit length, usually measured in decibels per kilometer (db/km). This attenuation results from scattering of light by the molecules of the glass and by impurities. Molecular scattering is responsible for about 0.5 db/km of loss, and the remainder of loss in real fibers is thought to be caused by contamination, mainly impurities from the crucible in which the glass is melted. Thus, containerless space production of glass fibers could greatly increase the quality of fibers. So far, fibers with an attenuation of 2 db/km have been produced in laboratories, and it has been calculated that with careful glass processing, and little or no container contamination, a theoretical minimum of db/km is possible.

If space processing could approach this minimum attenuation, it would be economically worthwhile because the lower the attenuation, the fewer repeaters that would be needed on a glass fiber cable. For example, a 2 db/km fiber would need about a repeater for every 10 km of ca-

ble. If space-produced fibers of 1 db/km could be produced this would mean a repeater only about every 20 km. Considering the enormous distances that would be covered by the cables, this halving of the number of repeaters needed could result in substantial savings.

### Space Bio-Factories

Some biological entities, including living cells which produce medically important substances, cannot be satisfactorily isolated with current chemical and physical separation techniques. Electrophoresis, the separation of particles of different mass/charge ratios in an electric field, is a widely used research and clinical technique. However, electrophoretic separation has not been very successful in the case of living cells because the cells tend to settle to the bottom of their containers. Theoretically, we could achieve very accurate separation in zero-gravity because the cells do differ in their mass/charge ratios, and applications would benefit from such a process.

A 1975 study by the National Academy of Engineering listed some materials which are prime candidates for cul-

turing and electrophoretic separation in space:

— Separation of the various kinds of human kidney cells may make possible pure tissue cultures of the specific cells which produce the enzyme urokinase, a substance which can dissolve blood clots in the body. Urokinase is now in very limited supply and very expensive, costing about

\$1,000 to \$1,500 per dose. Its production from purified cell cultures could reduce the cost by an order of magnitude or more, and stimulate its use in clinical research. In the U.S. alone, urokinase has the potential for preventing 50,000 deaths per year due to blood clots. Current requirements are for 500,000 to 600,000 doses per year.

— Kidney cells could be separated which produce the hormone erythropoietin, which stimulates the production of red blood cells in bone marrow. Thousands of patients with kidney disease or without kidneys are severely

anemic for lack of the hormone.

— The various types of white blood cells (lymphocytes) and antibodies and other products from lymphocytes could also be separated in space. These products characterize and may modify a patient's immunological response to transplants, tumor growth and other therapies or diseases.

There could also be isolation of blood proteins associated with clotting and other behavioral features of blood, with anticarcinogenicity, and with other functions

such as the metabolism of neurochemicals.

— Space-separated fractions of red blood cells (erythrocytes) having different electric charge, dipole layer, density and other characteristics, could serve as model substances for research.

— Space-separation techniques could also enable differentiation of nerve cells according to their behavior and functions. This could greatly aid neurological research.

So far, the only electrophoresis experiment in space has been carried out on the A.S.T.P. The experiment aimed at electrophoretically isolating urokinase-producing kidney cells in space, and returning the separated cells to earth in a sterile, "viable," condition so that they could be grown in culture. The cells indeed did come back sterile, a reasonable percentage of them grew, and those successful cells showed an increase in urokinase production one million times that of unpurified cells.

Since the techniques of preparing biological materials through electrophoresis in space are still in the preliminary research stage, their economic potential is unknown. A potentially serious problem is that these materials are especially sensitive to contamination and environmental changes. Research on electrophoresis to study these problems could be carried out on manned Spacelab missions of seven days or longer. One or two flights per year for five years should be enough to demonstrate feasibility and equipment design. Commercial production might take place after 1985 either in Spacelab or in a space station.

The Space Manufacturing Timetable

Space manufacturing will probably progress in three phases - flight research, process development, and, finally, industrial utilization. The flight research phase has already begun; a two-year program of drop-tower and aircraft tests in the late 1960s led to simple materials science demonstrations performed on Apollo flights 14, 16 and 17. This ground-based research was expanded to provide some 14 experiments and nine materials science demonstrations on the Skylab projects in 1973-74. The results of the Apollo and Skylab work were generally very good — in some cases, beyond expectations. Flight research will continue with experiments flown on sounding rockets to provide five-to-seven-minute periods of lowgravity operations until Space Shuttle flights begin; to date, three of the 15 rocket flights planned for the next few years have carried out 24 experiments.

The flight research phase has thus far centered around:

— Separation and purification of biological materials.

 Crystal growth of silicon for semi-conductor chips in microcircuits and solar cells with improved homogeneity.

— Metallurgical processes such as growth of the twophase eutectic alloys with a continuous, undisturbed, rod-like hard phase in the softer, matrix phase.

- Production of high-index-of-refraction glass by levita-

tion

The second, process development phase of space manufacturing in the 1980s will involve fundamental engineering and economic studies of materials behavior and space manufacturing equipment, and the design of pilot plant operations. This second phase will use continuing rocket flights, the Space Shuttle/Spacelab missions which will start in 1980-81 (see page 48), possible free-flying automated spacecraft for special investigations, and the Space Station. This work will require that scientists and engineers fly on board the Space Shuttle flights to satisfy their experimental objectives. It will be a period of emphasis on broad research studies rather than a single-point or random experiments — a time of very active learning about many processes and problems.

Progress in space processing as a discipline during this period will depend on how often investigators can obtain opportunities for short-duration flights from which experimental results can be quickly obtained and disseminated. As experience is gained, longer-duration flights will be desirable to more fully take advantage of the space environment. At some point during this phase we will definitely need continuous and permanent space facilities.

The third, industrial utilization phase of space man-

ufacturing in the 1990s could culminate in commercial manufacturing on space stations, as shown on page 49. This phase will emphasize productivity and economic return, and space industrialization will become more dependent on business and legal decisions than in prior phases. There will be continued process development on Shuttle/Spacelab flights; the use of space stations for manufacturing research, development, and pilot plant operations; and, finally, commercial production of selected products in space bases.

Organizing the Space Factory

Space manufacturing equipment organized according to function, has been set forth in a TRW study of space processing for N.A.S.A. In this study, we identified five space processing payload facilities (see page 42) to be flown individually or collectively on Spacelab missions starting in 1980 or 1981. Four of these payload modules represent distinct technical capabilities, while the fifth one, "core," provides for common needs. The core facility is flown on every mission. The other facilities are added as the mission dictates. These modules assume the manufacture of high-purity crystals, glass and silicon materials. The facilities can be extrapolated to space station flights. If space station flights are as long as 100 days, the space processing facilities will require some in-flight apparatus change-out and some recalibration.

Although very little new equipment will be required to start Spacelab space processing flights, some equipment technologies are yet to be demonstrated. They are:

— Acoustic positioning above 1,200°C. This is a means of positioning a solid or melt within a heated enclosure without having it contact any of the walls. The position is controlled by establishing a standing sound wave in the gas within the enclosure. Any solid object placed within the cavity will be held in one of the "troughs" or minimal energy nodes of the standing wave, since the acoustic energy increases uniformly in all directions from the nodal point.

— Vapor cycle cooling. The usual refrigeration cycles used on earth are dependent on gravity for some aspect of their equipment and, therefore won't work in gravity-free space.

— Contactless shaping and cooling. Molten glass must be cooled and shaped simultaneously to produce a solid product, and this must be accomplished without touching the melt, to avoid contamination.

- Solar furnace. This device is an enclosure in which concentrated sunlight is used in place of other conven-

tional energy sources to melt a material. Solar furnaces have long been used as curiosites on earth, but their performance in space has not been tested.

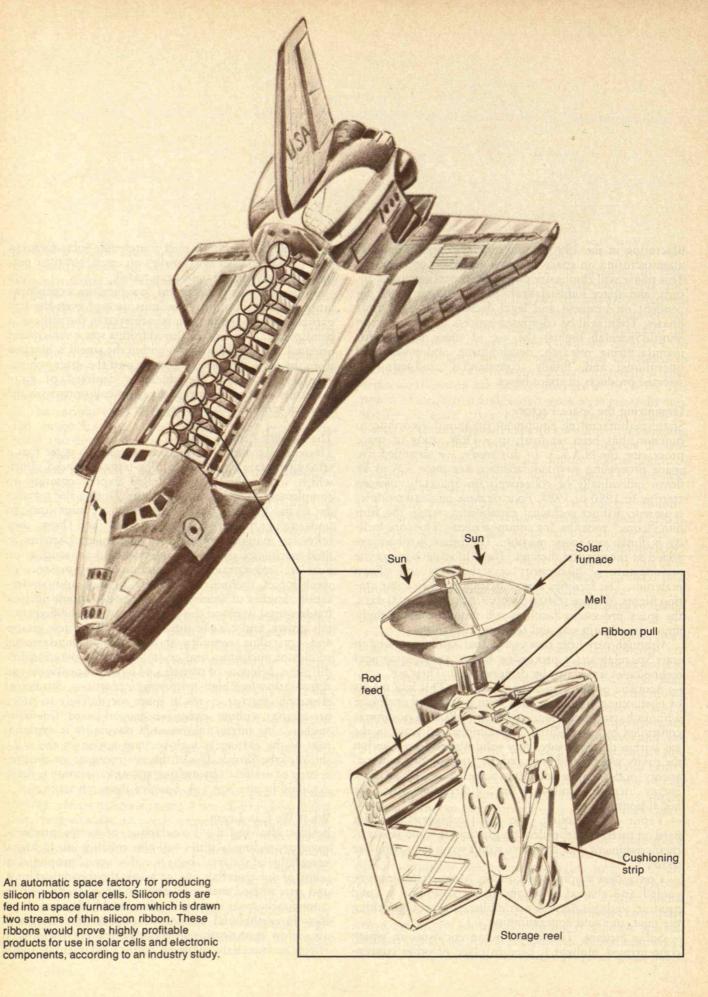
— Molecular shield device for low-pressure experimentation. Remarkably high vacuums, free of even the few particles in outer space, can be achieved in the wake of a hemispherical "shield" deployed from a space vehicle and oriented such that the region within the shield is blocked from the molecular stream flowing past the space vehicle. The region behind the shield is depleted of stray molecules as they are swept away by collisions with the external molecule stream (see page 47).

The Smooth Path to Space

Those involved in space processing research agree that a strong program should be a long-term, balanced effort, which will include ground-based experimentation to complement in-space investigations. During the remainder of the 1970s and the early 1980s we must come to understand the process phenomena and how they influence materials properties. Fundamental studies in fluid mechanics and heat transfer should concentrate on heat and mass transfer, convection in the presence of weak forces, thermal conductivity, boiling, and condensation. Studies of solidification processes should include fundamental work on the homogeneity of solidified crystals grown under weak forces. Research on new glasses and crystalline ceramics should include fundamental studies of nucleation and crystallization, convection-free diffusion, behavior of particle and liquid suspensions, and deformation-free high temperature reactions. Studies of electrophoretic processes in space are unlikely to prove productive without extensive ground-based feasibility studies. One interesting research possibility is exploitation of the extremely high-vacuum region in the wake shield of the Shuttle. Use of this environment for the processing of materials by melting and/or vaporation is being explored by the N.A.S.A. Langley Research Center.

### What We Can Learn

Besides allowing the manufacture of better products, space processing facilities will also enhance our technical knowledge of materials behavior. The actual properties of many of our materials are far below the theoretical limit, and space-based materials research promises to help us come much closer to these fundamental limits than do efforts in earthbound laboratories. Space processing will also allow investigators to eliminate the gravity-induced effects on materials, allowing better fundamental studies



of solidification, heat conduction in liquids and gases, phase transformations, the shape of the liquid-gas interface as controlled by surface tension, especially in temperature gradients, surface-tension-motivated flow, the dynamics of flames and combustion processes, the kinetics of vaporization and condensation, the dynamics of froths, and diffusion in fluids in a temperature gradient.

### The Blank Bottom Line

A major question is whether space manufacturing can be a profitable business venture. The space manufacturing business is quite new — the product forms have yet to emerge, costs are uncertain, very little market analysis has been conducted, and accurate cost-benefit evaluations are still required. The latter are complicated by the fact that they must take into account probable improvements in earth-based science and technology between now and the time space manufacturing can become a reality. There appear to be no severe technological problems to the equipment needed, but we do need answers to many questions about profitability, product mix, financing, supply and demand, public needs, international implications, organization, product standards, and governmentindustry obligations regarding proprietory data.

As you can see on page 43, a long list of technological, legal, and business factors affect commercial manufacturing in space. Each of these factors requires major study. In our concentration on economics, we must not forget that processes and products of high social value, such as better medicines, may develop and sustain the space processing program even before the appearance of profitable com-

mercial applications.

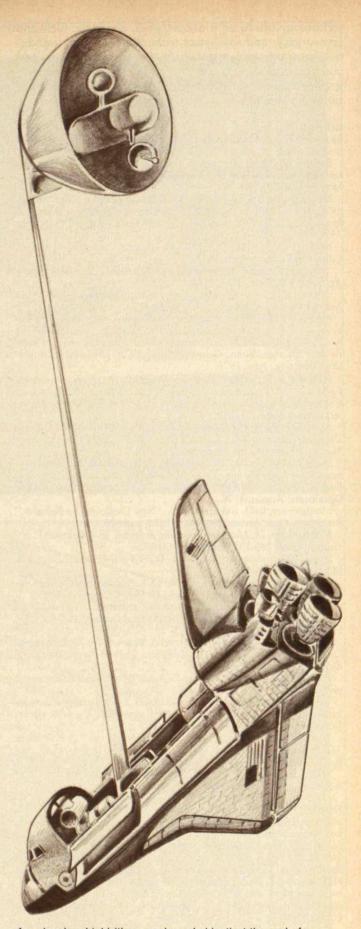
Space manufacturing research itself will not be exorbitantly expensive. Government (N.A.S.A.) funding for space processing research is now between \$4 and \$5 million per year, most of this being used to support the rocket flight program and its flight experiments, apparatus, and instrumentation. Industry investment is currently about \$1 million annually. Government funding of \$18 to \$22 million per year may be needed in the late 1970s through the 1980s to cover all research and development costs for experiments, equipment, and payloads, not including Shuttle transportation, operations, and mission control. Two factors appear critical in achieving space factories by the 1990s:

- An adequate, productive five- to six-year flight research period between 1980 and 1985 using Shuttle/ Spacelab payloads to verify in earth orbit reduced-gravity

principles and operations.

Rapid and complete diffusion of information about the first few successful commercial opportunities throughout the industrial community. The first commercial successes will probably occur by the mid-1980s. Space processing will require the endorsement and funding of the industrial community around 1980 to 1983 if the technology is to move from experimental to product-manufacturing activities.

We should certainly be prepared for surprises in our space manufacturing research. As N.A.S.A. scientist Hans F. Wuenscher pointed out in his pioneering 1972 paper on "Manufacturing in Space," if someone had asked Torricelli, inventor of the vacuum pump in 1650, what his vacuum environment was good for, and if Torricelli could have answered, "It opens the age of engines, radio, and television," nobody would have understood. Just as vacuum technology resulted in new products; cryogenic



A molecular shield (the cup-shaped object) at the end of a 100-meter extendable boom, is deployed from the Space Shuttle and blocks the stream of molecules flowing past the Shuttle, producing an ultra-high vacuum which may be used to produce materials of extremely high purity.

technology produced low-cost, pure, cryogenic fuels and cryosurgery; and solid-state technology was the foundation for transistors, metal oxide chips for computers, and communication devices; so the forthcoming reducedgravity technology will lead to products unknown and unpredictable today.

References

Bannister, T. C., "Materials Processing in Space," Appendix to the Out-

look for Space Report, M.S.F.C., April, 1975.

Barlow, G., "Space Processing of Biological Materials," paper presented to the A.I.A.A./M.S.F.C. symposium on Space Industrialization, May 26 to 27, 1976.

Beckey, I. and Mayer, H., New Initiatives, Aerospace Corp. report, 1976, summarized in "1980-2000 Raising our Sights for Advanced Space Systems," Astronautics and Aeronautics, July/August, 1976, page

Bredt, J. H. "Annual Review of Materials Science in Space," C.O.S.P.A.R. Paper R.I.I., 1975.

Spacelab Payload Accommodation Handbook, European Space Agency, S.L.P./2104, May, 1976.

Beneficial Uses of Space, General Electric, Contract NAS8-28179

from M.S.F.C., Final Report, November, 1975.

Hammel, R. L., "Space Processing Applications - Designing the Initial Space Transportation System Payloads Capability," presented at the A.A.S.-E.G.L.R. International Meeting on the Utilization of Space Shuttle and Spacelab, Bonn, Germany, June, 1976, published in Raumfahrtfarschung, June, 1976.

Hammel, R. L., Gilliam, A. S. and Waltz, D. M., "Space Processing Payloads — A Requirements Overview," presented at the Eurospace Conference, Monte Carlo, October, 1975, published in the British In-

terplanetary Society, J.B.I.F.

Feasibility Study of Commercial Space Manufacturing, McDonnell Douglas Astronautics Co. - East, Contract NAS8-31353 from

M.S.F.C., Final Report, December 20, 1975.

Space Station System Analysis Study, McDonnell Douglas Astronautics Co. - West, Briefings to the J.S.C. Engineering and Senior Review Boards. Contract NAS9-14958 from J.S.C., Presentation/Briefing Documents, August, 1976.

Montgomery, B. O. and Bredt, J. H., "New Challenges for Industry,"

Astronautics and Aeronautics, May, 1975, page 22.

Montgomery, D., Material Processing in Space, Jet Propulsion Laboratory, Report 760-131, September 4, 1975.

Space Industrialization, R.F.P. No. DCN 8-1-6-PP-00532, N.A.S.A.

M.S.F.C., May 18, 1976. Outlook for Space, Report to the N.A.S.A. Administrator by the Out-

look for Space Study Group, N.A.S.A. SP-386, January, 1976. Oriani, R.A., "Metallurgical Materials," presented at the A.I.A.A./ M.S.F.C. Symposium on Space Industrialization, at M.S.F.C., Huntsville, Ala. May 26 to 28, 1976.

Development of Improved Amorphous Materials for Laser Systems, Owens-Illinois, Inc., Contract 953846 from Jet Propulsion Laboratory,

final report, November 27, 1974.

Taylor, K. R., Space Processing Payload Experiment Requirements, presented April, 1976, Frascati, Italy.

Space Processing Payload Equipment Study, TRW Defense and Space Systems Group, Contract NAS8-31494 from M.S.F.C., final report, July, 1976.

Waltz, D. M., "Spacelab Payload Accommodation," A.A.S. paper 75-238 presented at the 21st annual A.A.S. meeting, Denver, Colo., Au-

gust 26 to 28, 1975.

Wuenscher, H. F., "Manufacturing in Space," Astronautics and Aeronautics, September, 1972.

Donald M. Waltz is a senior systems engineer in the Space Systems Division of TRW's Defense and Space Systems Group, Redondo Beach, Los Angeles, California. For the past ten years at TRW he has been involved in the project management of scientific and applications payloads for manned space projects such as the Space Shuttle, Spacelab, and Space Station. He is a member of several aerospace technical societies and has published papers on payloads for earth resources, communication/navigation, and space processing payloads on manned space missions. He has a B.S. degree in aeronautical engineering from Purdue University.

### How the Space Factory Will Evolve

The first space facility to be used for intensive studies of space manufacturing possibilities will be Spacelab (right, above), a general-purpose orbiting laboratory being developed by the European Space Agency to begin flights in 1980. Carried aloft in the cargo bay of the Space Shuttle Orbiter, and remaining there for the duration of its mission, Spacelab will fly both manned and automated missions ranging from seven to 30 days. Spacelab will consist to two basic elements a pressurized man-tended, laboratory-type module and an unpressurized pallet for mounting instruments for automated experiments. The Orbiter can carry the module only, the pallet only or both module and pallet.

Spacelab will support a maximum crew of four and will have power supplies and payload facilities to handle a wide range of space processing experiments. The Spacelab space processing program will seek answers, not only to problems in materials science and technology, but also to questions of how to organize working relationships between government and industry in space. The research will emphasize highvalue applications for space processing, with project proposals and equipment coming from the user community.

As data from the Spacelab research warrants, space processing research and later production could transfer to the Space Station/Space Base (right, below) that could be operational by about 1984. The Space Station could house research and prototype development during the early 1980s, with a view toward pilot plants by 1986 and a full-fledged space factory by 1990.

The Space Station as currently envisioned by N.A.S.A.

would be modular:

The crew modules would provide for basic crew needs such as eating, sleeping and recreation.

 The core module would contain basic communication and data management equipment and would provide the capability to dock with the Shuttle Orbiter.

The control module would house the major systems for environmental control and life support, for attitude control and stabilization and hygiene.

- The power module would house the primary electrical

power distribution and storage equipment.

Cargo modules, exchanged or added as necessary, would provide storage.

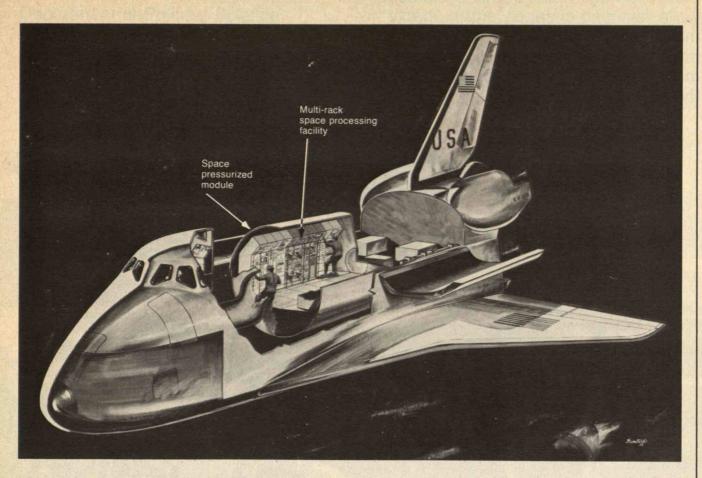
 Mission and laboratory modules would house the various scientific experiments and industrial processes to be carried

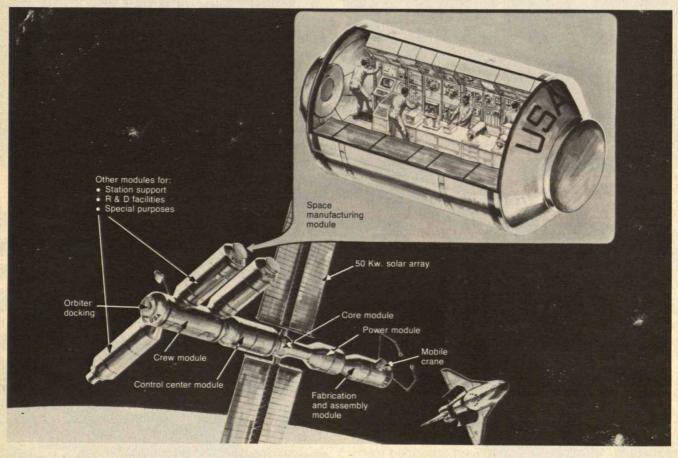
out on the space station.

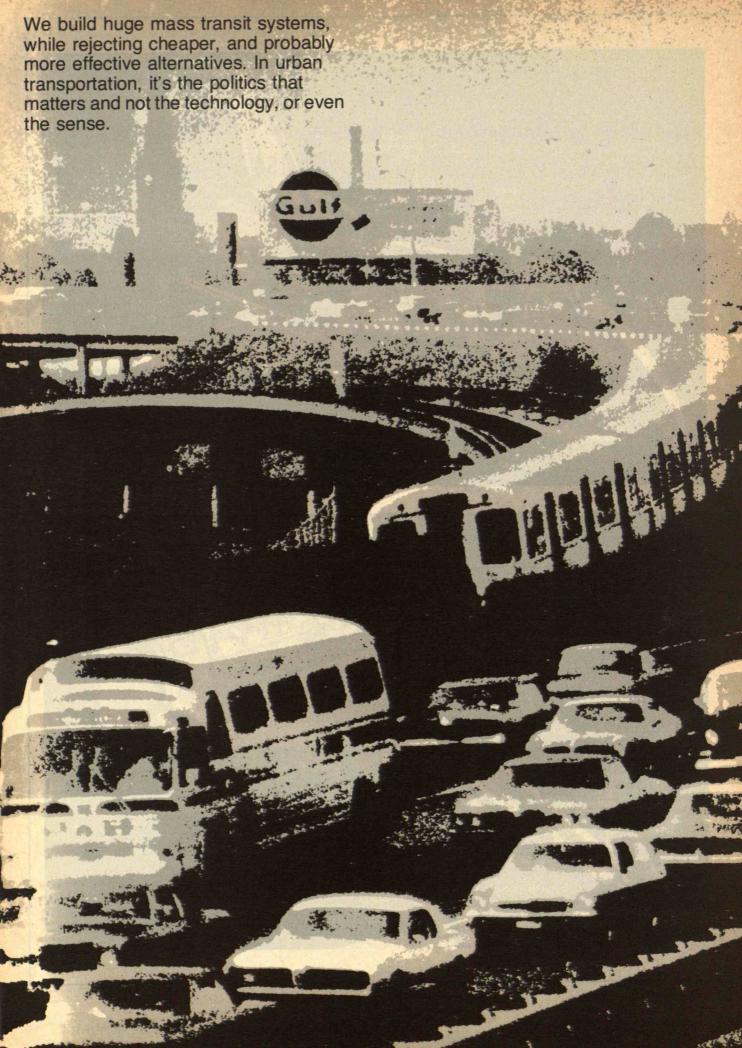
A crew of two to four experimenters and equipment operators will have to be supported for missions of 90 to 180 days of continuous operations aboard the Space Station. The station will need a floor area of 30 to 40 square meters, with a volume of 40 to 100 cubic meters, pressurized to a normal working environment and with compartments to protect the proprietary rights of the industries involved. For space processing the station will need to provide 25 to 30 kilowatts of power, voice and computer links with the ground, as well as onboard computer data recording capabilities; and it will have to maintain a low-gravity environment (about .001 g) while space-processing experiments are being conducted. -D.M.

Right, above: Cutaway of the Space Shuttle cargo bay shows a Spacelab module with facilities for materials science research.

Right, below: The Space Station factory concept, as envisioned by N.A.S.A. would consist of several basic modules, plus specialized research and manufacturing modules.







Alan Altshuler Department of Political Science Department of Urban Studies and Planning, M.I.T.

## The Politics of Urban **Transportation Innovation**

The so-called "urban transportation problem," which first emerged as a public issue in the 1950s, has undergone rapid redefinition in this decade. Decision-makers in the 1950s and 1960s were overwhelmingly concerned with expanding highway systems to accommodate the rising demand for automobile travel. The current decade, however, has been marked by the emergence to political

prominence of a host of new concerns.

During the late 1960s and early 1970s — particularly in densely settled, older cities like Boston and Cambridge - local movements protesting new highways increased public awareness that expressway construction entailed large social and environmental as well as financial costs. The same urban areas in which highway construction was fought most intensely tended to be among those most threatened by the continued precipitous decline of mass transit; and their public officials successfully lobbied to bring about a vast increase in the scale of federal transit aid in the 1970s. Environmental activists in 1970 achieved enactment of the Federal Clean Air Act, which set ambitious targets for air pollution reduction in urban areas. The Arab oil embargo of 1973-1974 and the national recession that followed it focused attention sharply on energy and fiscal constraints as important considerations in evaluating urban transportation policy options.

More generally, the 1970s have been characterized by a growing sense of environmental, energy, and public revenue limits and by a continuing sharp decline in the national birth rate. These developments have shifted attention increasingly away from the problems associated with rapid growth. We have become more concerned with how to maintain amenity, prosperity and a fair distribution of wealth in an era of fiscal austerity, modest population and economic growth, and periodic shock due to energy and

other shortages.

Within the framework of these changing public concerns and priorities, debate on urban transportation policy has also shifted focus. There is less concern with large-scale highway and transit projects, and more with improved management and utilization of existing facilities. Further, the current acute sense of resource scarcity has increased interest in alternative means to allocate limited transportation funds to increase mobility as well as reduce dependence on imported oil, minimize pollution, aid job development, and increase the options

of the elderly and the handicapped.

In short, there has been a growing perception that the urban transportation "problem" is in fact a complex set of problems. There has been less explicit recognition, however, that despite their awareness of these problems most Americans deem the current system on the whole to be highly successful.

The automotive era has certainly entailed the consumption of large amounts of land, energy, raw materials and labor, as well as great inconvenience for those who still depend on mass transit. But the auto has also afforded unprecedented mobility for the vast majority of adult Americans, together with numerous life-style and recreational opportunities.

### Public Policy and Market Choice

If academic critics of the urban transportation system typically neglect its more attractive features, politicians do not. Indeed, American politics has been historically oriented far more toward helping the current system evolve than toward constraining it. And the political system even now resists proposals for change that would inconvenience enterprises with significant economic stakes in the current system or individuals who have built their life styles around the expectation of its long-term stabil-

In focusing on the relationship between American politics and American urban transportation system, I will emphasize the causes of policy change over the past quarter-century. I shall seek as well to explain why recent changes in urban transportation policy are unlikely to significantly affect urban travel behavior.

I find it helpful to distinguish three types of decisions which have shaped patterns of travel in American urban

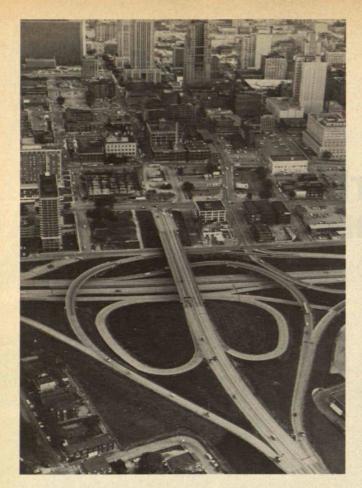
— individual and corporate decisions in the marketplace,

— public investment and subsidy decisions, and

- public regulatory decisions aiming to shape market incentives, and/or to constrain the options available to investors and consumers (e.g., selective taxation, direct regulation of prices or product characteristics, deliberate curtailment of supply, allocation of limited supplies).

Most discussions of urban transportation policy focus on public investment and subsidy. This focus is easily understood, as it includes the vast preponderance of what government has done to date with respect to urban transportation. This is far from saying, however, that government policy has been the predominant force shaping our urban transportation system, or that we can reshape the

Photo at left: D.O.T.; Graphics: Steve Glines



The massive highway projects which began in the 1950s were politically very popular because their supporters could argue that they would be paid for by consumers in the marketplace. Only recently has the public become aware of the high social costs of highways; for example, their need for large expanses of precious land in crowded urban areas. (Photo: D.O.T.)

system by manipulating the levers of investment and subsidization.

The private market has dominated the decision-making environment of American urban transportation over the decades. Nearly 90 per cent of urban transportation spending is in the private sector — 97 per cent if one includes the excise tax payments of highway users, built into gasoline and other purchase prices. Bearing in mind that the American political system is highly responsive to interest group and popular desires, it is not surprising that the public 10 per cent has rarely been expended with the aim of steering the private 90 per cent. Quite the contrary, government spending programs in urban transportation have aimed mainly at accommodating market trends.

The Interstate Highway program, for example, absorbed the vast majority of federal aid for urban transportation from the mid-1950s through the early 1970s. This behemoth construction project was consistently justified by its supporters as serving a visible public demand, as demonstrated in the marketplace, on the highways, and in the voting booth. Needless to say, the auto, oil, construction and trucking industries and labor unions took the lead in mobilizing support for the national program of interstate freeway construction. After all, they stood to ben-

efit most from high automobile and gasoline sales, from increases in the market for trucking services, and from highway construction contracts. Their advocacy was immensely aided, however, by the fact that their products were sweeping the field in the marketplace. And the nation's voters appeared to be highly supportive of highway spending. Constitutional amendments earmarking highway user taxes for highway expenditure programs were adopted in more than half the states during the late 1940s and early 1950s. In Massachusetts, the "Good Roads Amendment" was approved by a popular vote of six to one in 1948. (The Massachusetts voters did approve a subsequent amendment, in 1974, permitting the use of highway revenues for mass transit purposes, but one must not read the sentiments of the mid-1970s into the politics of the previous three decades.)

Orphan Transit

Even as urban highway spending burgeoned in the 1950s, mass transit languished. The conventional wisdom of the period was that transit — privately owned and publicly regulated in all but a few cities — should continue to meet all its costs out of the farebox. At the federal level it was considered sufficient, in order to establish the lack of legitimate national interest in mass transit, simply to note that few transit trips crossed state lines. Perhaps even more important, mass transit was viewed as a dying industry, rooted in obsolescent technologies and urban land-use patterns, increasingly rejected in the marketplace, and thus unworthy of public assistance. A popular analogy of the time was that subsidizing mass transit would be like spending public revenue to revive the blacksmith trade.

By the early 1960s, however, big-city mayors and transit officials were arguing that federal highway programs and regulatory policies bore significant responsibility for transit decline. One notable regulatory policy example was a provision of the Transportation Act of 1958 which permitted railroads to abandon intra-state commuter services if these were found to impair the financial strength of the railroads as interstate carriers. Urban officials recognized that they lacked the political strength to alter federal highway or railroad policies to benefit transit. So they campaigned for a direct program of transit subsidization. They asserted that all transit needed to remain viable as a significant, if minority, urban travel mode was limited assistance for capital expansion and modernization.

Thus, when the voters of the San Francisco Bay Area were presented with the BART rapid transit proposal in 1962, they were assured that no operating subsidies would be required. Similarly, when the Massachusetts legislature in 1964 authorized a major program of rapid transit expansion into the suburbs, it specified that all proposals for extensions were to be backed up by studies showing that they would cover their operating costs from the farebox. And the Federal Mass Transit Act of 1964 provided for capital assistance only. The Washington, D.C., Metro system authorized by Congress in 1969 was to cover a significant part of its capital cost, as well as all operating costs, from the farebox.

The national transit industry fell into an operating deficit in 1963, however, and by 1975 the national transit operating deficit reached \$1.7 billion. The rate of increase from 1970 through 1975 was 44 per cent a year. Should this rate continue through 1985, that year will see a \$65

billion deficit, quite aside from capital requirements. By the mid-1970s, roughly two-fifths of all federal aid for urban transportation went for transit purposes. There has been a 19-fold increase in federal transit assistance from fiscal year 1970 to 1977 (13-fold in constant dollars) — from \$0.13 billion to \$2.5 billion.

Yet the transit share of urban travel has continued to decline. The automobile accounts today for about 97.5 per cent of all passenger miles of travel in urban areas, up from 83 per cent in 1950 and 93 per cent in 1960. One can reasonably estimate, on the basis of numerous studies of urban travel demand and of consumer response to transit improvements, that the automotive share will remain at this level or increase slightly even if no additional highway capacity is constructed over the next several decades, assuming no change in the level of transit service. In this scenario of the future, peak-hour highway congestion would worsen, many people might hold down their commuting times by moving closer to their jobs, and employers might give higher priority to finding suburban and exurban sites accessible by currently underutilized roads. But these would be slight alterations in trends, and they would occur so gradually that scholars would make reputations by arguing about whether they had occurred at all.

Impotent Transit

What if dramatic improvements in transit service did occur? According to a recent study by the Office of Technology Assessment, doubling the transit vehicle mileage operated each day throughout the nation would generate only a 20 to 40 per cent increase in ridership. Eliminating transit fares and holding service levels constant would generate a 50 to 70 per cent increase in ridership. The study did not estimate what would happen if both policies were combined, but an increase of 60 to 100 per cent would seem most plausible. Yet even a doubling of transit patronage would raise the transit share of urban travel only to about 5 per cent, and it would offset less than a year's normal growth in travel by automobile. Implementing this combination in 1975 would have entailed a tripling of public spending for transit purposes by all levels of government — from roughly \$3 billion to roughly \$9 billion.

Besides the growing awareness that transit spending won't alter urban travel patterns greatly, there is increasing recognition that even dramatic increases in transit patronage wouldn't do much to meet such objectives as conserving energy and reducing air pollution. Much of the increased ridership generated by transit service improvements and fare reductions consists of people who did not previously make the trips in question. Another significant proportion consists of individuals who previously rode as automobile *passengers* rather than as drivers.

Buses and rapid transit vehicles are energy-efficient, low-pollution conveyances if they move with high average load factors. Increased service, however, usually means reduced load factors. If doubling transit vehicle mileage generated only a 20 to 40 per cent increase in patronage, and if half of the new patrons were making new trips or had previously traveled as automobile passengers, then the result would almost surely be an *increase* in energy consumption and air pollution emissions.

How, then, can one account for the crumbling of public resistance to transit operating subsidies in the 1970s, which culminated in 1974 legislation providing for fed-



The Atlanta rapid transit system, now under construction in a city with an excellent freeway system, is a prime example of politics triumphant over economics, says the author. In recent years it has been politically more feasible to propose spending decades and billions of dollars to develop new rail rapid transit systems than to spend years and millions of dollars to develop bus rapid transit on existing streets and highways. (Photo: D.O.T.)

eral participation in the cost of transit operating deficits (though federal aid is still unavailable for highway operating expenses)? And how can we account for the meteoric growth of public transit budgets in the 1970s?

It is striking that the federal transit program was first proposed by big-city liberal Democrats in the 1950s, and that the Mass Transportation Act of 1964 was viewed as a major liberal triumph of the Kennedy-Johnson years. Yet the greatest flowering of the program occurred under Presidents Nixon and Ford, both generally viewed as highly conservative.

The explanation, I believe, is that transit proved to be a policy for all perspectives on the urban problem. Though its direct supportive constituency was relatively meager and highly concentrated in a small proportion of Congressional districts, its ideological appeal proved to be extremely broad. Transit could be embraced whether one was for the economic vitality of our cities, for protecting the environment and stopping highways, for energy conservation, for assisting the poor, the elderly, and the handicapped, or simply for getting the other guy off the road so as to be able to drive faster. This is not to say that transit was in fact an effective way of serving all these objectives — simply that it was widely believed to be so.

Thus, the Nixon-Ford Administration, while striving to

separate itself from the big-city, big-spending, pro-black, welfare-state image of the Johnson Administration in domestic affairs, felt comfortable promoting a rapid increase in federal mass transit spending. Transit turned out to be the ideal centerpiece for the urban policy of a conservative administration. Though clearly of high priority to urban spokesmen, transit advocacy did not stir class and racial antagonisms and its very ineffectiveness as a means of altering urban travel patterns may have been an asset. Automobile and highway interests had no reason to feel threatened by a mass transit spending program.

A Congressional Marriage

In fact, highway advocates and transit advocates worked well together. During 1973 and 1974, a new coalition of the two developed in Congress. The House and Senate Public Works Committees, traditional bastions of highway support and extremely powerful in the Congress, bid successfully for mass transit jurisdiction. They sought to allay the fears of transit supporters by arguing - and demonstrating — that they could produce larger budgets for transit. Their cooperation was also essential if the pro-transit objective of giving large urban areas flexibility to use highway aid allocations for transit purposes was to be achieved. Highway advocates welcomed the change as a means of reestablishing the near-unanimity that had characterized highway program support in the 1950s and 1960s. The result was a marriage of highway and transit interests in the Congress, officiated by the senior members of the Public Works Committees (with the two most significant actors hailing from Texas and West Virginia). The progeny of this marriage during 1973 and 1974 included a big three-year highway spending bill; a six-year transit spending authorization which provided for operating subsidies and sharply increased funding; and flexibility for urban areas to trade their highway aid allocations for transit grants of equal magnitude.

More recently, however, the romance with transit has begun to pale. Fiscal austerity has driven policy makers to ask more incisive questions about the benefits to be anticipated if large increases in transit spending are authorized, and to demand more persuasive evidence in support of the answers they are offered. Transit advocates have relied increasingly on energy and air quality justifications, but their cases have suffered from lack of support by energy and environmental officials. Indeed, studies financed by the Federal Energy Administration and, to a lesser extent, the Environmental Protection Agency have been prominent among those debunking

transit as a cost-effective means of furthering their objectives.

### Innovative Alternatives

Because of the growing sense of the limits of conventional highway and transit programs, there has recently been an upsurge of interest in more innovative means of solving the "problems" of urban transportation. These include:

— improved traffic management techniques (e.g. computerized signal systems responsive to traffic conditions, exclusive bus-carpool lanes),

- new and improved services (e.g. subscription bus,

dial-a-ride, vanpool),

— regulatory measures (e.g. to force the development and marketing of safer, less polluting, more fuel-efficient automobiles), and

— auto travel disincentives (e.g. gasoline tax increases, gasoline rationing, new or increased highway tolls and

parking restrictions).

Needless to say, combinations of these innovations may be more effective than each one by itself. Consumers are more likely to respond to vanpooling, for example, if they also face gasoline rationing or parking restrictions at

their employment sites.

Controversies too complex and numerous to detail here have swirled around the numerous innovations available in recent years. I would like to summarize, however, the broad conclusions that I have reached in seeking to explain why some innovations have been readily accepted while others, with equal or greater potential as cost-effective technical solutions, have been treated as politically untouchable.

### The "Customers" Are Always Right

The central point is that the American political system strives, wherever possible, to accommodate new demands without disturbing existing policies and behavior patterns. This approach to political problem-solving tends to minimize conflict. It maximizes the ability of decision-makers to define the policy "game" as one of winners without losers, and thereby to produce the greatest possible ratio of satisfied to dissatisfied "customers."

Although the political system has certain decision-making orientations of a highly conservative nature, its task is to manage an extraordinarily dynamic society, which generates a constant stream of new demands and opportunities. This paradox tends in practice to be resolved as follows: First of all, the political system appears to have a very weak commitment to any particular valve.

At the same time, the system is highly open to innovative ideas that can be injected into the ongoing stream of activity with minimal disruption of existing programs, institutional arrangements, and behavior patterns. Stated another way, the system does not treat apparent tensions among policy objectives as inescapable sources of headon conflict. Rather, it seeks politically to blur the tensions and technically to find ingenious new means of reconciling the objectives.

It follows that, other things being equal, change strategies will be less politically acceptable the more they inconvenience voters. As a vital corollary, the visibility of the connection between the public action and the voter inconvenience is a key desideratum. It matters a great deal to elected officials whether the connection between public action and private inconvenience is clear and immediate

or blurred and deferred.

Politically Ranking Technical Options

With these features of the political system in mind, we can rank alternative change strategies in urban transportation

in order of political acceptability:

First, the ideal innovation is one that consumers will buy voluntarily in the marketplace, at a price high enough to cover its cost. If such an innovation requires public implementation, it greatly helps to be able to contend that decisions on use are voluntary.

Public highway programs were long promoted and defended on this basis. Decisions to use the highway system were perceived as voluntary; payment for the highway was proportional to use; and the system appeared to pay its own way. More recently, of course, resistance to highways has developed as constituents have perceived that:

— highway programs have major external effects by no means adequately covered by user payments;

- highways influence the spatial distribution of activities, and thus tend to compel their own use;

 decisions to use the existing highway system are not properly interpreted as votes in favor of future expansion; and

 the highway revenue-expenditure system includes major cross-subsidies.

Current government efforts to promote voluntary carpooling and vanpooling, likewise, fall into this first category of innovation; the great uncertainty is whether consumers will respond to them. The evidence to date suggests that carpooling and vanpooling programs might be of enormous value during a prolonged oil embargo, but that in more "normal" circumstances they are most unlikely to significantly change urban commuting behavior. Carpools and vanpools entail little or no monetary saving for most employees (who do not sell their cars when they pool); the pools cost commuters in time and flexibility; and they require an employer commitment that only a few companies have any interest in making. Areawide programs of carpool promotion and matching have to date been complete flops. The major successes have been at individual employment sites where large employers have made an intense effort to encourage pooling — usually because the company's expansion has created a parking shortage that would be highly expensive to alleviate by physical expansion.

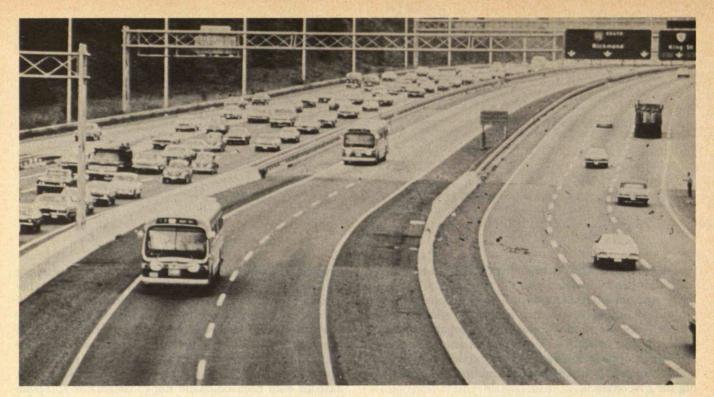
A second category of political acceptability includes innovations that do entail some measure of perceived compulsion, but which alleviate problems and reduce, or at least do not significantly increase, the cost of service. Ideally, such innovations involve direct compulsion of corporate enterprises rather than the public at large (e.g., government regulations which set performance standards for new automobiles). Alternatively, such innovations entail the exercise of traditional government powers in relatively unobtrusive ways (e.g., the use of improved traffic

signal systems).

At best, performance standards for new automobiles induce the auto manufacturers to provide the public with better products at lower or essentially unchanged prices. At second best, they lead to higher purchase prices which are more than offset by reduced average lifetime costs to the purchaser and to society at large. For instance fuel efficiency may be improved, or human and economic loss from accidents may be reduced. Even when such requirements for automobiles are not themselves cost-effective, they may be defended as diverting manufacturer energies from even less cost-effective activities, such as annual auto styling changes.

Traffic management innovations likewise vary widely in obtrusiveness and in the extent to which they force trade-offs. The least obtrusive are traffic signal improvements that reduce congestion and increase overall highway capacity. Such measures improve service for all users, generate a sense of enhanced individual freedom rather than increased compulsion, and represent the inexpensive exercise of a long-accepted government responsibility.

At the other end of the scale are proposals that entail reductions in service quality for some classes of users in order to benefit others — e.g., buses and carpools. The ill-fated Los Angeles "diamond" lanes on the heavily



Although reserved bus lanes on freeways seem an inexpensive, effective way to aid bus transit, the lanes have proven politically disastrous. Public protest over the inconvenience caused to drivers by the lanes has killed many of these plans. (Photo: D.O.T.)

traveled Santa Monica freeway were in this category. These lanes, one in each direction, were set aside for five months in 1976 for exclusive use by buses and carpools (three or more occupants) during peak travel periods. The result, at least temporarily, was increased congestion for those denied access to the diamond lanes. The storm of public protest and media ridicule surrounding the diamond-lane experiment ended only when a federal judge ruled that the project required a full-scale environmental impact statement. State transportation officials, feeling that the experiment had been a technical success but a political disaster, decided neither to appeal the ruling nor to prepare a statement. The message was duly noted by transportation officials throughout the nation, sharply diminishing the future prospect of lanes already in service being reassigned for exclusive bus-carpool use.

Such reactions help explain why in recent years it has been politically more feasible to propose spending decades and billions of dollars to develop new rail rapid transit systems than to spend years and millions of dollars to develop bus rapid transit systems using reserved lanes on existing streets and highways. For example Atlanta, a low-density region with an excellent freeway system, is currently constructing a very costly rapid transit system. The District of Columbia is building a far more extensive system which now seems likely to cost about \$6 billion. While the District is short of freeway capacity within the central city itself, its streets are wide and straight. Moreover, its employment is spread out over an extremely large "core" area probably more suitable for service by surface buses making numerous stops than by a subway system with only a few lines and with stations a half mile or so apart.

In the middle range of acceptability among traffic man-

agement techniques are those that do discriminate among classes of users, but that do not significantly reduce service quality for even the least favored. Examples include newly added freeway lanes reserved for buses and carpools, and "wrong-way" bus lanes on freeways whose remaining off-peak lanes can still carry traffic with little or no congestion. Although such innovations have been instituted in recent years with little controversy, their prior neglect reveals the American political system's historic preference for expanding resources over managing them efficiently — where management would entail explicit tradeoff decisions among users.

Ducking the Blame. . .

In the next broad category of acceptability are measures that do entail significant public or private cost for the benefits they confer, but in a manner that permits diffusion and deferment of the blame. Examples include regulations mandating automobile hardware improvements, transit spending increases, and infrastructure investment decisions.

In the case of hardware improvements, elected officials can reasonably hope that voters will vent any resentment they feel about price increases upon the automobile companies. Thus, the officials can get immediate credit for voting on behalf of safety and clean air; the cost issue can be deferred until the standards come into effect; and then they can attack the companies for their greed in raising prices to cover the cost of the mandated equipment. (Of course, if the companies can meet the standards without raising prices, all the better.)

Local elected officials have sought quite successfully in recent years to deal with rising transit costs by securing increased state and federal assistance. The federal tax



Dial-a-bus, vanpools, and subscription buses are among the more innovative solutions to the urban transportation problem. Without outside incentives, such as parking restrictions or gas rationing, however, their success will be limited. (Photo: D.O.T.)

structure produces, at constant rates, revenue growth more rapid than the rate of national income growth. Moreover, during the last two decades, public resistance to large federal budget deficits has crumbled. Thus, Congressmen could vote for many large, new spending programs during the 1960s and 1970s without having to vote for new taxes. Individual legislators at all levels, of course, always have the option of voting for increased spending and against increased taxes. And legislative leaders have numerous means to blur tax votes to make it difficult for constituents to judge the actions of their own representatives. In Massachusetts, for example, a \$400 million tax increase in 1975, the largest in the history of the Commonwealth, was enacted as part of the overall state budget. Furthermore, the entire omnibus bill was passed without a roll call in the state Senate — after a preliminary roll call had permitted a majority of the Senators to go on record as against the tax program.

Infrastructure investments have long been popular at the state and local levels mainly because their costs can be diffused over long periods of time by bonding, and over large geographic areas by the use of federal aid. Until the new program of transit operating assistance got under way in 1975, federal aid for urban transportation had always been available solely for capital projects.

### ... Is Not Always Possible

Finally, the least acceptable transportation innovations are those that entail substantial costs or interference with established patterns of behavior, imposed in such a manner that the blame will fall clearly and inescapably upon the public officials who adopt the innovation. Even within this category, of course, one must distinguish among innovations on the basis of the degree to which

blame is inescapable by the responsible officials, the intensity of public support for the objective, the degree of public understanding and acceptance of the method as an efficacious means of serving the objective, and the extent to which the established patterns to be affected are entrenched in law or formal contractual agreements. A few examples may serve to illustrate these distinctions:

— Public decisions to adopt auto-restraint strategies generally entail very clear responsibility for the inconvenience and/or cost visited upon the public. A decision to raise the gasoline tax, to restrict parking availability, to impose a parking surcharge, or to curtail gasoline supply calls forth protest as clearly focused upon the responsible decision makers as political blame ever is.

— Public support is generally far more intense and consensual for those objectives that entail the preservation of life, health, and/or current patterns of behavior than those which simply entail improved amenity or prosperity. Thus, the public will accept major tax increases and rationing of key commodities in the midst of a popular war — World War II, for example, but not Vietnam. Similarly, the public will accept without complaint some cost and inconvenience in peacetime to deal with a clear and immediate danger, such as airplane hijacking.

As threats are perceived more diffusely, or as low statistical probabilities for each person, however, resistance to inconvenience appears to grow very rapidly. Thus, the automobile ignition interlock system, required by Congress on 1973 cars to compel the use of seat belts, produced widespread voter outrage, leading to Congressional repeal within several months after the 1973 models appeared on the market. A similar fate was met by the Environmental Protection Agency's proposals in 1973 and 1974 to restrain motor vehicle travel in selected metropolitan areas to achieve Congressionally mandated air quality standards. (Congress prohibited the E.P.A. from imposing taxes or surcharges and, subsequently, from expending any funds for the implementation of parking restrictions.)

Even when a crisis has greatly weakened resistance to measures that entail interference with established travel behavior, and an action "mood" has clearly been established, the political system still tends to seek out those measures that entail the lowest risk of voter backlash. Measures will tend to be more acceptable as the restraints they entail seem relatively trivial, as they fit comfortably within existing areas of public jurisdiction (e.g., traffic rules), as their efficacy has been established beyond con-

troversy, and as they are inexpensive.

Further, these characteristics of potential measures frequently interact in dynamic fashion. If, for example, a measure entails behavioral change that is widely perceived as extremely difficult or unpleasant, the public will resist the belief that it works. For example, the public found the ignition interlock system extremely annoying and fastened upon every argument that might discredit it—such as the large numbers of automobile owners who had found ways of disconnecting it. It mattered little that seat belt use in cars with the interlock system averaged much higher than in cars without it, and that it would very likely save thousands of lives a year. The public impression became widespread that the interlock had been a useless as well as unpopular measure, a classic case of "bureaucratic bungling."

Finally, in evaluating the potential acceptability of innovations that entail interference with established behavior patterns, one must consider how firmly these patterns are entrenched in law or formal contracts. For example, many analysts believe that the taxi industry could serve the public more effectively if current regulatory restrictions were removed on the number of licensed taxis per locality. But because these restrictions, where they exist, are rooted in formal legal processes, the opportunities for resistance to change are far greater than if current restrictions were merely customary. Proposals to allow free entry into taxi markets stir particularly intense resistance because the government-imposed scarcity has in most localities made current permits worth a considerable amount of money. Thus, regulatory relaxation is viewed by the industry as a form of property confiscation. Taxi medallion owners' arguments to political and regulatory officials will sound more persuasive the longer such limits have prevailed and the higher the capital values that have accrued. Also, the courts are more likely to protect these arguments.

Similarly, new transit proposals frequently assume that current work rules, union jurisdictions, and patterns of labor compensation can be modified. Again, however, the current practices are rooted in much more than custom. They have been incorporated into formal labormanagement contracts, and frequently into public laws and regulations as well. The result, in nearly all cases, is that change can come about only by formal agreement between labor and management. Such agreement may be possible, but invariably at much higher cost than the innovators originally anticipated.

The Prospects for Change

In light of the foregoing analysis, we shouldn't be surprised that it has proven more feasible to increase public spending programs and to stop particularly disruptive highway projects than to manage existing systems more effectively or to reshape the market framework within which consumers make their travel decisions. Nor should we be surprised that the most feasible innovations in recent years have been:

- those entailing new or improved services, to be used or not on a purely voluntary basis by consumers,

- traffic management improvements which do not entail degradation of service for any class of users, and

- regulatory measures directing the auto manufacturers to produce more energy efficient, safer, less polluting cars.

The evidence to date indicates that the first two categories of innovation, with one exception, are unlikely to affect significantly the character of the urban transportation system. The exception is demand-responsive special services for the elderly and handicapped. Such services may indeed prove an important boon to beneficiaries, and significantly enhance the system's equity. Such services are likely to entail relatively large subsidies per trip served, but for a commendable purpose.

Demand-responsive transit services, efforts to promote carpooling and vanpooling, and increases in conventional transit service coverage, however, seem likely to attract only very small numbers of patrons in the years ahead. They will reduce automobile traffic volumes, if at all, only by an amount equivalent to several weeks or months of normal growth. Traffic management improvements, even constrained by the need to avoid degradation of service for any group, do have a high potential for costeffectiveness. This is because they are relatively cheap and non-disruptive rather than because their benefits are par-

ticularly great. Their potential is mainly to aid traffic flow (thereby further encouraging automobile travel) and to enhance in very minor ways the attractiveness of travel by bus transit and carpool. Since there are relatively few opportunities for special lane treatments in congested corridors without inconveniencing general purpose traffic, traffic management approaches appear to have little potential for altering the balance among modes in the existing urban transportation system.

The bright spot in this picture is that regulations to improve automobile performance characteristics seem to be working, and at quite modest cost to consumers.

By 1985 the average new American car will probably get twice the gas mileage of its predecessors of the early 1970s, will emit only about 5 per cent of the carbon monoxide and hydrocarbons emitted by its predecessors of the mid-1960s, and will include safety features reducing the risk of auto travel to significantly under half the level of the mid-1960s. If achieved, these remarkable accomplishments will constitute powerful evidence of the ability of private enterprise to deal with important social concerns when given clear public directives.

In sum, then, the American political system has vitally important characteristics of a "conservative" nature, but it is also highly attuned to dealing with the radical nature of modern reality. In reconciling these two orientations, American politicians are drawn inexorably to technological innovation as a path to problem-solving with minimal disruption of existing social arrangements and behavior patterns. Where technology is unable to do the job, the system often appears woefully ineffective. In dealing with at least some of the major problems of urban transportation, however, the system appears to be within a decade of achieving an unambiguous triumph.

Altshuler, Alan, "The Decision-Making Environment of Urban Trans-

portation, *Public Policy*, Spring, 1971.

Altshuler, Alan and Curry, Robert, "The Changing Environment of Urban Development Policy - Shared Power or Shared Impotence,"

Urban Law Annual, 1975, pp. 1-43.

Bruce-Briggs, B., "Mass Transportation and Minority Transportation," The Public Interest, Fall, 1976.

Gakenheimer, Ralph, Transportation Planning as Response to Controversy: The Boston Case, Cambridge, Mass.: M.I.T. Press, 1976.

Kemp, Michael and Cheslow, Melvyn, "Transportation," in *The Urban Predicament*, William Gorham and Nathan Glazer, eds., Urban Institute, 1976, pp. 281-356.

Owen, Wilfred, Transportation for Cities, Brookings Institution,

Transportation Research Board, Paratransit, Special Report 164,

Webber, Melvin, "The BART Experience — What Have We Learned?" The Public Interest, Fall, 1976.

Alan A. Altshuler, Professor of Political Science and of Urban Studies and Planning at M.I.T., has had extensive experience in the politics of urban transportation. He was chairman of the Massachusetts Governor's Task Force on Transportation that in 1970 advised Governor Francis W. Sargent to halt work on planned expressways in Greater Boston and to develop a new transportation plan for eastern Massachusetts. The result was a massive reorientation of Boston's transportation policy away from large highway projects and a switching of highway funds to mass transit projects. Professor Altshuler served as Secretary of Transportation and Construction for the Commonwealth of Massachusetts from 1971 to 1975. He has conducted extensive research on such transportation innovations as dial-a-ride and is author of The City Planning Process: a Political Analysis (Cornell University Press, 1966). He is currently completing a book tentatively entitled Innovation and the Problems of Urban Transportation (M.I.T. Press). This article draws on research conducted by the author and others at M.I.T. as part of U.S. Department of Transportation Contract No. DOT-OS-50240. The views expressed, of course, are exclusively the responsibility of the author.

# **Books and Comments**

Continued from p. 11

to reduce hydrocarbon emission from automobiles may themselves generate even more dangerous pollutants. Should the whole catalytic purifier program be scrapped, or are better converters feasible?

The sorry state of E.P.A.'s in-house research was revealed last spring in a strange document. Congress ordered E.P.A. to produce two research programs: one for the year ahead, the other for the next five years. The agency responded with more than 130 single-spaced pages itemizing every project conceivably related to its mission. No priorities were mentioned, and some who perused the list estimated the work could hardly be completed within this century — even if E.P.A. could recruit most of the nation's scientific manpower fulltime.

Yet E.P.A. does have a staff of about 150 highly qualified research sceintists and engineers. The trouble is that at any given time more than half are likely to be detached for other duties, such as giving

testimony or making routine measurements of pollution.

Another book on this aspect of E.P.A.'s difficulties — a severe threat to its potency and credibility — needs to be published. We can only hope that it will be written by someone with the sensitivity and keen insights of John Quarles.

George A. W. Boehm is a free-lance science writer and member of the Review's Editorial Advisory Board.

### **Nisbet**

Continued from p. 5

become increasingly valuable, until they exceed the cost of simple replacement. However, my own experience suggests that the actual savings in time and convenience gained by discarding household goods is not very great. If we assessed the full costs to society of setting aside land for dumps, polluting air and water, depleting raw materials, and degrading the landscape with litter, we might discover that we would all be better off spending an hour a month washing and sorting. The

next step is to devise a system that will ensure that individuals fulfill their social obligations.

At present, even the modest regulations to diminish waste are not enforced — a fact well known to the gulls and rats at my town dump, who live happily on the garbage discarded there in violation of solemn ordinance.

Ian C.T. Nisbet, who writes regularly for Technology Review, is Associate Director of the Scientific Staff of the Massachusetts Audubon Society.

# As specialists, we have to engineer and build our coils better.

# Standard Type CH Hot Water Coil

ASH Type Removable Core Preheat Coils with carbon steel tubes, copper fins solder coated, welded joints.

### Aerofin keeps the pressure on optimal thermal efficiency and more life-cycle cost value

That's precisely what you should expect from a company that has pioneered in heat transfer technology since 1923. Today's capital outlays, energy costs and payback considerations recommend Aerofin system economics.

The heat's on heat recovery, Aerofin coil capability scores in a simple "run-around" system (70% efficiency range)—recovery challenges compounded by freezing temperatures/ethylene glycol solutions/corrosive gas/special metal applications, environmental blight controls—to demanding disciplines of wet scrubbers/preheat combustion air.

Aerofin earns the highest industry rating in standard computer-selected coils. High GPM/few rows or low GPM extra rows coil combinations, high coil-pressure capability, cupro nickel carbon steel, copper, stainless steel, or alloy coils to fight corrosion/contamination. New or retrofit, Aerofin specialization/performance never looked so good.

### Ask for data on standard coils

HOT WATER COILS—HEATING AIR
Type CH\*- Bulletin CH-72
Type C\*- Bulletin CCW-71
Type MP\*- Hot Water Booster—
Bulletin MP-72

STEAM COILS—HEATING AIR
Type B - Flexitube Steam—
Bulletin B-58
Type CH - Steam-Bulletin CH-72
Type MP - Steam-Bulletin MP-72

Universal Steam Coil High Pressure Steam Coil

Non-freeze Steam Coil Type A - (1" tubes) Bulletin A-61 Type B - (5%" tubes) Bulletin B-58

REFRIGERANT COILS
COOLING AIR
Type DP - Direct Expansion—
Bulletin DP-66

WATER COILS COOLING/DEHUMIDIFYING Type C\*- Bulletin CCW-71

Removable Header
Type R\*- Bulletin CCW-71
Type RC\*- Bulletin CCW-71

\*ARI Certified



Aerofin is sold only by nationally advertised fan manufacturers. Ask for list.

AEROFIN OFFICES: Atlanta / Boston / Chicago / Cleveland / Dallas / Los Angeles / New York / Philadeliphia / San Francisco / Toronto / Monfreal / Mexico D. F. / Geneva, Switzerland AEROFIN CORPORATION (CANADA) LTD., Gananoque, Ontario

# Flipping "Super-Cents" for the Old Howard

Space was short, and "Better Late Than Never" was too long for the March/April issue; most of it was postponed until this issue. My only defense: better late than never!

JAN 1 was improperly stated; it is revised in this month's "Solutions" section.

I'm asked to announce that the fifth annual Mathematics and Statistics Conference of Miami University, Ohio, will be held there (Oxford, Ohio, 45059) on September 30 and October 1, 1977; the theme is "Number Theory — Pure and Simple"; Friday papers will be directed at college teachers and researchers, and those on Saturday are for high school teachers and students at all levels. For further information write Stanley E. Payne at Miami's Mathematics Department.

### Problems

We continue the practice of presenting previous problems never completely solved.

NS7 This problem, from Frank Rubin, appeared as 1970 Oct/Nov 2. R. Robinson Rowe sent in a (very) partial solution and some months later Judith Q. Longyear and Michael Rolle responded, but I do not believe a complete solution ever appeared.

Let N be some fixed positive integer. Show that there exist positive rational numbers  $a_1, \ldots, a_N$  such that for any m,  $1 \le m \le N$ 

$$S(m) = \sum_{i=1}^{m} a_i^3$$

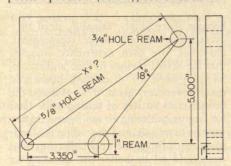
is the square of a rational number, and S(N) = 1.

MAY 1 A chess problem from Gary A. Ford:

White begins a chess game with the usual set-up, while Black has only his king (in the usual position). What is the minimum number of moves White needs to achieve mate, assuming Black tries to avoid it? Is the first man moved by White the same in all minimal solutions?

MAY 2 Neal MacClaren used to be Director of Quality Control at Brown and Sharpe Manufacturing Co., a large ma-

chine tool firm. He enclosed a typical drill pattern problem (below); solve for x.



MAY 3 R. Robinson Rowe recalls that "a whimsey" at M. I.T. 60 years ago was, "Let's flip a penny: heads we go to The Nip, tails to the Old Howard, and if it lands on edge we stay here and study." He speculates that The Nip may be gone after 60 years, recalling that Cambridge was then a local-option dry town and The Nip was a respectable saloon in Boston, much patronized by students, located on Tremont Street between Park Station and Boylston Street. The "Old Howard" was a burlesque theater, a bit less respectable than its only competitor, Waldron's Casino, located between Scollay Square and Haymarket Square. At the Old Howard, he says, the chorus line wore tights a/c Boston "blue laws," and The Nip served draft beer for five cents a schooner and mixed drinks two-for-aquarter. Mr. Rowe's question:

Suppose we had flipped a "super-cent" made of N cents epoxied together in a cylindrical form. Given that the diameter of a cent is 12 times its thickness, what is the nearest integer N for (a) The "supercent" with equal changes of *heads*, *tails*, or *edge*? (b) The "super-cent" with equal chances of *face* or *edge*?

MAY 4 An interesting problem from Paul Mailman concerns palindromes (numbers like 181 or 247742, i.e.  $a_0 a_1 \dots a_n$  with  $a_i = a_{n-1} o \le i \le n$ ). Mr. Mailman writes:

Have you ever seen a proof that if you reverse a number and add it to itself, and repeat that process, you will eventually get a palindrome? I've heard that it's true,

and have found no counter-examples, but can't prove it.

359	79
953	97
1312	176
2131	671
3443	847
	748
	1595
	5951
	7546
	6457
	14003
	30041
	44044

MAY 5 Russ Nahigian will undoubtedly get me into trouble with this since I've played backgammon even less often than either bridge or chess — but here goes. He writes:

I offer the following problem to those who know the rules of backgammon. Given the original board setup, play any 3 initial dice of your choosing such as 6-6, 5-5, 6-1, etc. to lock up the 2 black pieces in the corner of your home table with a perfect prime. That is, the black pieces in the corner are locked in such that they cannot move even 1 space (or point) with the 6 openings in front blocked by closed points. (Assume the black corner pieces stay in one place during the 3 rolls of the dice.)

(Anyone in the Boston area interested in joining a backgammon club should call Mr. Nahigian at 617-494-2015 days or 617-648-6219 evenings.)

Speed Department

MAY SD1 The following, entitled "Fun at the Factory," is from Smith D. Turner: Punch any number (try your weight) into a calculator in the Rad Mode, and then punch the cos key repeatedly; alternate punches give two series that converge to give

### 0.7390851332

Try another number — say your phone number — and you get the same! Thus, a constant emerges that, like e, depends only on the process and not the specific data. What is this new fundamental constant of nature 1 have discovered?

MAY SD2 Gregory James Ruffa wants all the positive x's such

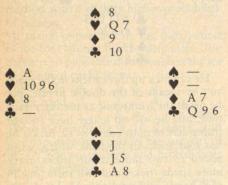


that X gives the same answer whether evaluated top down or bottom up.

### Solutions

JAN 1 As noted above, this problem was incorrectly stated. South is to make *four* of the five tricks against any defense. The correct problem reads:

With a no-trump contract, how can South, who is on lead, make four of the remaining five tricks of the following hand against any defense?



Try again, folks.

JAN 2 Replace each letter by a unique decimal digit to make a correct equation:

ROBERT

× F KENNEDY

The answer is

 $\begin{array}{r}
 192516 \\
 \times 3 \\
 \hline
 0577548
 \end{array}$ 

George H. Ropes and Bill Swedish each submitted this solution without saying how it was obtained, R. Robinson Rowe came close, and the "Allan J. Gottlieb Arithmetic Endurance Award" has been sent to Dennis Sandow to be given to his SR-52 which discovered the solution after 218 hours of calculating. They would have gone after a uniqueness proof but that would have taken 29 days (and then the solution would have been "better late than never").

JAN 3 Prove that if  $X, \ldots, X_n$  are distinct real numbers (distinct natural numbers are all right, too) and n > 1, then the finite sequence  $\{Xi\}_{n=1}^n$  has a monotone subsequence of length greater than  $\sqrt{n}$ . This difficult problem has been nicely solved by Ron Moore:

In the problem statement we must change "greater than" to "greater than or equal to," since if  $n = m^2$  is a perfect square, a sequence of length n may be

constructed whose longest monotone subsequence is of length m. The sequence consists of m blocks of length m:

$$\begin{array}{l} m,m-1,\ldots,1 \ , \ 2m,2m-1,\ldots, \\ m+1,\ldots,m^2,m^2-1,\ldots, \ m^2-m+1 \end{array}$$

Any decreasing subsequence must be entirely contained in some block and so has at most m elements; any increasing subsequence can contain at most one element from each block and thus has at most m elements. Given the distinct numbers  $X_1, \ldots, X_n$ , we list them in this order from left to right and form a directed graph  $G_o$  by drawing an arc from  $X_1$  to  $X_j$  if i < j and  $X_i < X_j$ :

$$\widehat{\dot{X_1}} \ \dot{\dot{X_2}} \ldots \dot{\dot{X_{n-1}}} \ \dot{\dot{X}_n}$$

If there is an arc from X<sub>i</sub> to X<sub>j</sub>, call X<sub>j</sub> a predecessor of X<sub>j</sub>; also, the number of arcs terminating at a vertex will be called its input valence. Let So denote the set of points with input valence 0 in graph Go. (Note that So is not empty since certainly  $X_1 \in S_0$ .) An element of  $S_0$  is less than all elements to its left; so if  $|S_0| \ge \sqrt{n}$ , the elements of So form a decreasing subsequence of length  $\geq \sqrt{n}$ . If  $|S_0| < \sqrt{n}$ , form a new graph G1 by removing from Go all elements of So and all arcs emanating from them. Let S1, denote the set of vertices with input valence 0 in graph G1. Again, S<sub>1</sub> is non-empty, and each element of S<sub>1</sub> is less than all points to its left in G<sub>1</sub>. So, if  $|S_1| \ge \sqrt{n}$ , the elements of  $S_1$  form a decreasing subsequence of length  $\geq \sqrt{n}$ ; if  $|S_1| < \sqrt{n}$ , define graph  $G_2$  by removing from G1 all elements of S1 and all arcs emanating from them. This process continues until either

(a) some set  $S_i$  is found with  $|S_i| > \sqrt{n}$ , in which case the elements of  $S_i$  form a decreasing subsequence of length  $\geq \sqrt{n}$ ;

or

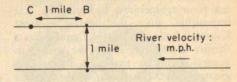
(b) the original graph  $G_0$  is exhausted. If case (a) never occurs, then, as  $S_0$ ,  $S_1$ , ... are successively removed, less than  $\sqrt{n}$  points are removed at each step. After  $m = \lceil \sqrt{n} \rceil$  steps, less than  $m \sqrt{n} \le n$  points have been removed from the original graph  $G_0$ , so  $G_m$  is non-empty and the set  $S_m$  is non-empty.

Now observe that, given an arbitrary element P of  $S_i$  ( $0 < i \le m$ ), there is a predecessor  $p^1$  of P where  $P^1 \in S_{i-1}$ . (For by construction P has input valence 0 in graph  $G_i$  but positive input valence in  $G_{i-1}$ ; so there is an arc  $P^1 \to P$  where  $P^1$  is in  $G_{i-1}$  but not  $G_1$ , i.e.,  $P^1 \in S_{i-1}$ .) Consequently, we can choose an element  $Y_m$  of  $S_m$  arbitrarily and successively choose  $Y_{m-1}, \ldots, Y_0$  such that  $Y_i \in S_i$  and  $Y_i$  is a predecessor of  $Y_{i+1}$ . Then  $Y_0, Y_1, \ldots, Y_m$  is an increasing subsequence of length  $m+1=\lfloor \sqrt{n}\rfloor+1>\sqrt{n}$ .

R. Robinson Rowe and Roger Milkman have also responded.

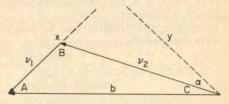
JAN 4 A swimmer, who swims at a constant rate of two miles per hour relative to the water, wants to swim directly from point A to a point C, which is one mile

downstream and on the other side of a river one mile wide and flowing one mile per hour. At what angle should he point himself, relative to the line AB (perpendicular to the river)?



The paucity of solutions to the last two problems is counterbalanced by the outpouring of responses to this one. The following is from Eugene Bedal:

First obtaining a general formula seemed to help avoid mixing of values. Per diagram,



let V<sub>1</sub> = 1, velocity of river V<sub>2</sub> = 2, velocity of athlete x, y = 1 each, the coordinates given.

Then b =  $\sqrt{x^2 + y^2}$ and Sin A =  $y/b = y/\sqrt{x^2 + y^2}$ .

From the Law of Sines:

 $(\sin C)/V_1 = (\sin A)/V_2$ , and  $\sin C = (V_1 \sin A)/V_2$   $= V_1/V_2 \cdot y / \sqrt{x^2 + y^2} = 1/2\sqrt{2}$ Thus  $\alpha = 45^\circ - \text{Csc}^{-1} 2\sqrt{2}$ .

Also solved by 31 other readers (the list is simply too long to print), including the proposer, Ted Mita, and an anonymous employee of General Mills Chemicals.

JAN 5 An ounce of gold can be drawn into 50 miles of wire or hammered into a sheet of 100 square feet. Which is thicker, the wire or the sheet? Hint: Gold, unlike currencies, does not float.

This problem also received a large response; I selected the following from Carl M. King:

According to my old Handbook of Chemistry and Physics, the density of gold is 19.26 gm/cc. The thickness of the gold sheet 1 calculate to be:  $t = 6.8316 \times 10^{-6}$ .

The diameter of the gold wire I calculate to be:

 $d = 1.9884 \times 10^{-4}$ 

which means that the wire diameter is the greater by a factor in excess of 29. I note that this factor is a function of the density of the gold. For a lesser density the factor would be less, so I wondered what would be the density of a material for which the wire diameter would be equal to the sheet thickness. Or to state the question in another way: Is there a value of density where the answer to this problem re-

verses, and the thickness of the sheet would be the greater? So I set the ratio to unity, and let the density be the unknown. To satisfy this condition I find:

density = .023 gm/cc

which is an impossible condition at normal room temperature and pressure. It is impossible, since the lightest element known is hydrogen gas (H2), and it has a density of .090 gm/cc. So the answer in general terms is that the diameter is greater than the thickness, as those terms are defined in the problem, regardless of the density of the gold.

Also solved by 21 readers (once more the list is too long to print), including the proposer, Homer D. Schaaf, and the General Mills Chemicals employee.

Better Late Than Never

1973 MAY 3 A fine analysis has come from R. C. Lacher:

In essence, the problem was to decide when the symbol



makes sense. The solution by R. R. Rowe (and evidently also Bob Baird, Walter Hill, Neil Judell, Peter Kramer, Albert Mullin, Harry Nelson, John Prussing, and Harry Zaremba) which appeared in the October/November 1973 issue, is not complete. By concentrating too intensely on the upper end of the convergence interval, these fellows evidently missed perhaps the most interesting property of "Infinitely Stacked Exponents": the symbol (\*) is not convergent for very small values of x.

To facilitate further explanation, I will make some definitions:

Let 
$$E_1(x) = x$$
 and  $E_{n+1}(x) = x^{E_n(x)}$   
for  $n = 1, 2, ...$  and  $x > 0$ ; and definite

 $\ell(\mathbf{x}) = \lim_{n \to \infty} \inf E_n(\mathbf{x})$ 

$$u(x) = \lim_{n} \sup E_n(x)$$

for x > 0. Rowe et al. discovered that l(x) $= + \infty$  for  $x > \sqrt[6]{e}$  and  $u(x) < + \infty$  for 0  $< x \le \sqrt[6]{e}$ . Here are some other facts:

$$\ell(x) = \lim_{x \to \infty} E_{2k+1}(x) \text{ and}$$
 (1)

$$u(x) = \lim_{k} E_{2k}(x)$$
 for  $0 < x \le \sqrt[p]{e}$ .

Both  $\ell(x)$  and u(x) are continuous on the interval

$$0 < x \le \sqrt[e]{e}. \tag{2}$$

$$\ell(\mathbf{x}) = \mathbf{u}(\mathbf{x}) \tag{3}$$

if and only if  $\frac{1}{e^e} \le x \le \sqrt[e]{e}$ .

Thus, the symbol (\*) is defined if and only if  $\frac{1}{2} \le x \le \sqrt[6]{e}$ . The "solution" to the equation

by replacing (\*\*) with the equation  $x^a = a$ is valid as long as the symbol (\*) makes sense, i.e., as long as

$$\frac{1}{e} \le a \le e.$$

The red herring in this problem is that the equation xa = a makes sense for any a > 0! J. J. Andrews and I discovered the above facts in connection with our solution to the simultaneous functional equations

$$x^{a(x)} = b(x), x^{b(x)} = a(x)$$

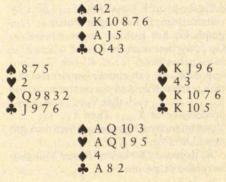
(paper to appear in Aequationes Mathematicae).

1975 JUN 5 In the February issue solutions to this appeared under both "Solutions" and "Better Late Than Never." Although this sounds impossible, it's true. When the March issue was submitted, the BLTN was dropped due to space limitations; but meanwhile room "appeared" in February, so in it went although for that issue it was not late. At any rate, the author of that (correct) response was William J. Butler, Jr. This obsoletes the (incorrect) Gottlieb-Chandler version given in the solutions section (and I thought topology was complicated). Responses have subsequently been received from Kevin Czuhai, Draper Kauffman, John F. Chandler, and Philip E. Oshel.

1976 JUN 1 Gary Schwartz from the Charles S. Draper Laboratory informs me that when D-Notes ran this problem credit was given to Test Your Bridge Play by Edwin B. Kantar.

Albert J. Fischer and Charles E. Blair claim to have better ways to play the hand. Mr. Fisher's follows:

The solution proposed by Mr. Ingraham is almost identical with my own. However, there is a hidden trap. Consider the following distribution:

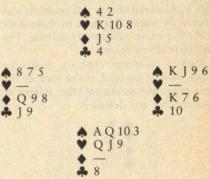


Mr. Ingraham's solution consists of drawing two rounds of trump ending in his hand and then leading low to the &Q. He states that if East can win the &Q with the &K, he is still all right so long as either:

(a) East has the AK and AJ, or

(b) West has no more than the AJ and two small spades. Let us examine each of these propositions:

(a) East has the distribution shown above, which includes & K, & K, and & J. Assume for convenience that East returns a small club after he has won his &K (any minor suit card will do). South wins with the A and finds himself in an almost impossible situation:



He can pick up three tricks in the spade suit by means of the double finesse, but he needs the trump suit as the entry each time, and he will no longer have enough trump left over to come to 12 tricks: he has four tricks in the bank which, when added to two more trump tricks, three more spade tricks, and two ruffs (one in each hand), will total only 11. Mr. Ingraham's error was in counting a second diamond ruff, which cannot be taken since the trump is needed as transportation to dummy for the double finesse in spades.

In the position shown, the only chance I can see for South is the forlorn hope that West has been dealt the singleton AK. South should cash the AA, dropping the offside King (and causing West to move several feet back from the table), cross to dummy with a trump, and finesse against East's AJ. The losing club goes on the AQ, and South trumps two black cards in dummy and two red ones in his hand for a total of 12 tricks: four in the bank, three spaces, one trump (transportation), and four ruffs.

(b) Everyone has the distribution shown originally except that East's A I has been exchanged for one of West's small ones. Mr. Ingraham states that he intends to arrive at 12 tricks by means of "three high spades, one spade ruff, two diamond ruffs, the AA, and two more trump tricks." I do not see how South can come to "three high spades" with this initial position — a finesse of the AQ followed by A and a spade ruff will drop the AJ but not the .K. It appears to me that this line of play suffers from the same problems as before - namely, an insufficient supply of tricks.

The simple solution to the transportation dilemma is to draw only one round of trumps, ending in hand, prior to leading the low club toward the Queen. Now South truly is in command of the situation. He wins the club (or diamond) return in hand, crosses to dummy with a trump, and takes the double finesse in spades. When this wins, he can return to dummy with a third round of trumps to repeat the finesse, At this point he still has two trumps in each hand and can cross-ruff for the remainder of the tricks.

1976 JUN 2 Stephen F. Wilder noticed that Sally may be speaking nonsense and when I suggested this problem for the York biweekly puzzle, my colleague Joe Malkevitch immediately asked "what shape is the table." But then he's a geometer.

1976 JUN 5 B. Rouben and William J. Butler have responded.

1976 O/N 1 R. Robinson Rowe has a method with a slightly higher probability of success:

Of major importance is the distribution of the four trumps held by defenders. The measure of probable distribution is the set of binomial coefficients:

One hand 4 3 2 1 0
Other hand 0 1 2 3 4
Probability 1 4 6 4 1

Probability 1 4 6 4 1 in 16ths. Those four cards are Q, 10, 9, and 8, and it is important to consider the support of the Q. The possibilities and probabilities may be tabulated:

One hand	Other hand	Chance	factor	product
Qxxx		.125	0	0
Qxx	x	.375	0	0
Qx	xx	.375	1	0.375
Q	xxx	.125	0.547	0.068
		1.000		0.443

"Chance" is derived from the distribution table above. Note that 3,1 and 1,3 each had 4/16 chance, adding to 1/2; since any one of the four cards might be the singleton, this ½ is divided to 3/8 for Qxx and 1/8 for Q alone. "Success Factor" is the probability of success for each distribution. For Qxxx and Qxx, the factor is 0, because the Q will take one trick and another will be lost in a minor suit. For Ox, trumps are drawn without loss, two clubs are ruffed in dummy after giving up a club, and the contract is airtight—that is, the success factor is 1. Finally, if the Q is alone it falls, but the J in dummy must be used to pick up the last outstanding trump. Now declarer's best chance is to set up a diamond 13-er. Dummy holds AKXXX and he can ruff twice. Opponents hold seven diamonds; if divided 4-3, they will fall. The chance of this is determined by the binomial coefficients:

 One hand
 7
 6
 5
 4
 3
 2
 1
 0

 Other hand
 0
 1
 2
 3
 4
 5
 6
 7

 Probability
 1
 7
 21
 35
 35
 21
 7
 1
 in 128ths

Thus the chance of a 4-3 or 3-4 distribution is 70/128 = 0.547, which is the success factor and the success product is 0.068 as shown. This is additive to the total success probability of 0.443. More precisely, this is 227/512, which equals 0.443 359 375. For this strategem to work, one must make sure of entry cards

in dummy and closed hand. For either contingency, Qx or Q, the north-south play to the first 6 tricks would be, with an underscore marking a led card and asterisk marking a winning card:

Trick	North	South	
1	♥ 2 ♥ 6	₩5	
2	₩ 6	₩8	
3	♦ A*	•2	
4	<b>♦</b> 6	<b>4</b> *	
2 3 4 5	<b>A</b> 2	♠ A*	
6	<b>A</b> 3	♠ K*	
Then if trump		Territoria de la constantina della constantina d	
7	<b>3</b>	♣ A*	
8	♣ J	<b>4</b> ,	
losing, and for	club or hea	ert return	
9	♣ 7*	2 5	
10	♦ K*	2 6	
11	7	♣ 5 ♣ 6 ♠ 5*	
12		<b>1</b> 0	
13	↑ J* ♦ 8	A 6*	
	0 611	<b>TO</b>	
But if singleton	n Q rell,	A 5	
7	<b>♠</b> J*	A 5	
8	♦ K*	♣ 4 ♠ 6* ♣ A*	
9	♦ 7	♠ 6*	
10	* 3	♣ A*	
11	♣ J	<b>\$</b> 5	
losing, and on any return			
12	<b>♠</b> 7*	♣ 6	
13	♦ 8*	<b>♣</b> 10	
winning 70/128 of the time.			

In the first alternative, at Trick 9, I showed the play for a club or heart return. Opponents have no spades. If a diamond is returned,  $\phi K$  wins, as for Trick 10, and dummy has an unneeded trump to play later.

1976 O/N 2,3 William J. Butler, Jr., has responded to both.

1976 O/N 4 William J. Butler, Jr., Naomi Markovitz, Boyan Baldwin, and B. Rouben have responded.

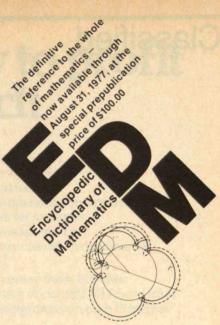
1976 O/N SD2 Roger Stern feels that the proposed method would be difficult to carry out.

1976 DEC 2 Naomi Markovitz, George H. Ropes, Judith Q. Longyear, Robert F. Barnes, Scott W. Peterson, David J. Pogoff, K. Haruta, and James Larson have responded.

1976 DEC 3 James Larson, K. Haruta, Judith Q. Longyear, Winslow H. Hartford, Naomi Markovitz; Hiroshi Ono, William E. Cooper, Gene Bedal, and Harvey Elentuck have responded.

1976 DEC 4 Judith Q. Longyear, Naomi Markovitz, Winslow H. Hartford, K. Haruta, and James Larson have responded.

1976 DEC 5 Winslow H. Hartford and Judith Q. Longyear have responded.



by the Mathematical Society of Japan edited by Shôkichi Iyanaga and Yukiyosi Kawada translated by the Mathematical Society of Japan with the cooperation of the American Mathematical Society translation reviewed by Kenneth O. May two volumes 7 x 111/4 inches each 840 pages each, 436 articles—appendices—27,000 index entries ISBN 0 262 09016 3

\$100.00 through August 31, 1977

\$125.00 thereafter

This monumental work covers in concise, thorough fashion the entire mathematical realm from Abel and Abelian Groups to Zeta Functions. It includes recent developments in the most active fields, articles on mathematical programming and theoretical physics, and historical perspectives. It is the most highly concentrated distillation of mathematical knowledge ever prepared. The Encyclopedic Dictionary of Mathematics will be consulted - and consulted often - by mathematicians and students as varied in their specialties and interests as the articles are in their subject matter; more than a few will one day ask how they ever managed without the EDM!

### The MIT Press

Massachusetts Institute of Technology Cambridge, Massachusetts 02142

### Classified

### **PUBLICATIONS**

- THE EXCITING NEW **JOURNAL** of incisive commentary and dramatic, well-plotted fiction. \$12/year Box 31312, San Francisco, Ca. 94131

HOW TO EARN MONEY AS A CONSULTANT (Including specimen contracts.) Send stamped, self-addressed envelope to Business Psychology Int'l, 2407/13 Pacific, Virginia Beach, Va.

### INVENTOR'S DIGEST

Articles of lasting interest! American Society of Inventors Magazine, 5 issues, \$10, sample issues \$1, 1709 Fidelity Building, Philadelphia, Pa. 19109

### REAL ESTATE

### INDIAN COVE SOMETHING SPECIAL

An investment in tomorrow - a solar home today. 217 acres, 60 homesites. 135 acres protected by conservation trust. Private roads, sandy beaches, tennis court/dock/clubhouse. Fishing abounds. A boatyard on the Cove. An established community on Buzzards Bay w/wooded building sites. If you're looking for something special, request our catalog.
INDIAN COVE TRUST Tower Bldg., Marion, Mass. 02738

### **PROFESSIONAL**

- Free catalog of clear plexiglas office products.
- \* Nomograph construction \$100 per variable
- \* Three-dimensional drafting teaching aid \$25
- \* Shop sliderule for work rpm \$5. JFC, 214 Security Mutual Building, Binghamton, N.Y. 13901

### WANTED: IDEAS!

Suggestions, formulae, "great names" in science and technology, to make a living "textbook on walls" out of a dull four-story stairwell in the technology wing of a community college.

Objective: To turn a stairwell into a learning-well

Needed: Your ideas and comments

Payment: The heartfelt thanks of future technologists and technicians

Please send your ideas to: Mark Garber, Career Education Department, Mohawk College of Applied Arts and Technology, 135 Fennell Ave. W. Hamilton, Ontario, Canada L8N 3T2

### NON-PROFIT ORGANIZATIONS

### THE DOMINICAN INSTITUTE OF TECHNOLOGY

founded by MIT alumni, is a non-profit, privately operated organization to train underprivileged Dominicans. We believe that a country must develop itself from within, and the most powerful tool toward this aim is the technical education of its people. For information on how you can help, please write: Instituto Dominicano de Tecnologia, Inc., Apartado Postal 214 Zona 2, Santo Domingo, Dominican Republic. Attention: Eduardo Sagredo, MS '68

Classified Ads: \$3.00 per line; two-line minimum. (Allow 32 letters & spaces for first line; 50 letters & spaces for each additional line.)

Display Ads: \$25.00 for first column inch; \$20.00 for each additional inch.

Copy Deadline: one month prior to publication date. Payment in advance of insertion required for less than three insertions in one year. Send orders to Classified Section, *Technology Review*, M.I.T., E19-430, Cambridge, Mass. 02139.

Y1976 Bill Swedish notes that 43  $= 19 + 7 \cdot 6$ 

1977 FEB SD1 William Hornick has taken this problem seriously. The problem asked which common (non-archaic) English verb had no infinitive, and the answer was given as "can" in the sense of "to be able." Mr. Hornick offers eight other common, non-archaic English verbs which also have no infinitive forms and explains why:

I could go . . . 1. Could as in I would go . . . 2. Would as in 3. Should as in I should go . I shall go . . (He will go . . .) 4. Will as in 5. May as in I may go . . . 6. Might as in I might go . . . Ought as in I ought to go . . 8. Used I used to go . . . (when it means as in "formerly")

All eight of these (plus can), are auxillary and/or operator verbs. They are never used without another verb (or verb form). Of course, most times the other verb form is implied rather than expressed. (Ex. "Are you going to write a letter?" "I should.") Implied with "I should" is "I should write." Furthermore, the first six in my list are always dependent on conditional (in a grammatical sense) situations. The last two need not be.

PERM 2 Smith D. Turner ( f dt) prefers a variant where any mathematical function except greatest integer is allowed and the object is to use as few 4s as possible. He can make 0 to 9 using a total of 13 4s.

Proposers' Solutions to Speed Problems Both solutions are courtesy of the Editor: SD1 The unique solution of cos(x) = x. SD2 For x > 0,

$$X^{(x^X)} = (X^X)^X$$
 implies  $X^{(x^X)}$   
=  $X^X \cdot X$ 

implies X = 1 or  $X^X = X^2$ implies X = 1 or X = 2.

Allan 1. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Activities at York College of C.U.N.Y. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y. 11451.

# We want your company to profit from our research

Advances in marine technology through MIT Sea Grant research and related marine programs are creating new business opportunities for U.S. industry. To keep companies like yours abreast of developments that can lead to new commercial products and services, the MIT Sea Grant Program formed the MIT/Marine Industry Collegium.

In its two full years of operation, the Collegium has become a working partnership between MIT Sea Grant and U.S. industry. The Collegium works closely with member companies to translate marine research into profitable commercial applications. It also provides a forum for government and industry to cooperate with MIT in developing an even more effective Sea Grant research program.

At the core of the Collegium program are the Opportunity Briefs, concise, well-documented publications through which we

 identify promising new applications of a specific area of marine research or technology, and

 assess these applications in terms of technical feasibility, market potential, and economics.

Follow-up meetings, workshops, and special programs enable Collegium partners to explore these topics in detail and in person—with MIT faculty, Sea Grant staff, and subject experts.

Collegium members receive four *Opportunity Briefs* a year. Past *Briefs* have summarized the technology, markets, and economics of:

polymers derived from crustacean shells

· marine mining of sand and gravel

advances in underwater welding

underwater telemanipulators

· robot submersibles for underwater instrumentation

· closed-cycle aquaculture for molluscs

- · electron irradiation of sewage sludge
- · computer models for near-coastal environmental engineering

Collegium partners also enjoy these benefits:

· a comprehensive summary of current MIT Sea Grant research projects and background on each Principal Investigator

· Abstracts of all new MIT Sea Grant reports

· Information on significant marine-related events at MIT

· "Up-date seminars" to review past Brief topics

· Opportunities to propose student research projects By joining now, you can help us shape the program and *Brief* topics for the coming year.

The Collegium is supported on a matching funds basis. Members companies, MIT, and the federal government, in accordance with the National Sea Grant Act, share the Collegium's operating costs. The corporate membership fee is \$500 a year.

To join the Collegium or for more information, write or call:

Norman Doelling
MIT Sea Grant Program
Massachusetts Institute of Technology
Cambridge, MA 02139
Telephone: (617) 253-4434

# The MIT/Marine Industry Collegium



American Cyanamid Company **Arcair Company** Arthur D. Little, Inc. Avco Everett Research Laboratory, Inc. Becton, Dickinson Research Center **BOC** Limited Bolt Beranek and Newman Inc. **Boston Edison Company** Campbell Soup Company Castle & Cooke, Inc. Chevron Research Company Compass Publications, Inc. Consolidated Controls Corporation Continental Oil Company Deepsea Ventures, Inc. **DeLaval Separator Company** Digicourse, Inc.

EG&G, Inc.

Corporation

**Environmental Devices** 

Akzona, Incorporated

Environmental Research and Technology, Inc. Exxon Research and **Engineering Company** General Dynamics Corporation, **Electric Boat Division** General Electric Company, Industrial and Marine Steam **Turbine Operations** General Electric Company, Re-Entry and Environmental Systems Division Gibbs & Cox, Inc. BF Goodrich Goodyear Aerospace Corporation Groton Associates, Inc. Grumman Aerospace Corporation Frederick R. Harris, Inc. Hercules, Inc. Hooker Chemical Corporation Imperial Chemical Industries Limited

Kennecott Copper Corporation Klein Associates, Inc. Kockums Shipyard Lockheed Missiles & Space Company, Inc., Ocean Systems Lone Star Industries, Inc. MacLaren Atlantic Limited Marine Colloids, Inc. Maritime Administration Massachusetts Science **Technology Foundation** Massachusetts Port Authority Mitsui & Company, Ltd. Mobil Oil Corporation Montedison S.p.A., Research & **Development Division** New England Power Company Nomura Research Institute Oceaneering International, Inc. Perry Oceanographics, Inc. Proto-Power Management Corporation

Interocean Systems, Inc.

Raytheon Company, Submarine Signal Division RCA Corporation Sanders Associates, Inc. Sea-Land Services, Inc. Seaward International, Inc. Specialized Systems, Inc. Sperry Marine Systems Standard Oil Company (Indiana) Stanwick Corporation Stone & Webster Engineering Corporation Sun Shipbuilding & Dry Dock Company Texaco, Inc. Union Carbide Corporation U.S. Coast Guard, Office of Research & Development

Westinghouse Electric

Zapata Corporation

Corporation, Oceanic

Woodward-Clyde Consultants

# Take this 30-second "Success Test"

Question one	Do you have a first-generation product you'd like "re-thought" to a second-generation degree of sophistication and then produced for you?	YES NO	
Question two	Have you developed a machine whose use would expand the market for the basic material you supply, but you don't want to go into machine building?	YES NO	
Question three	Do you have the rights to produce and distribute a "foreign" designed product that you'd like "Americanized" for easier production, greater acceptance and increased profitability?	YES	

If you answered YES to all or any of these questions, contact Artisan as the first step toward success. We have designers and engineers, with expertise in many disciplines, available to you on an as-needed basis. Plus, an in-house machining, fabricating and assembly capability that can do part, or all, of any job you need done.

Listed below are typical projects we've handled for others. UNIT COSTS RANGE FROM \$1,200 to \$26,000. A telephone call to (617) 893-6800 is all it takes to find out what Artisan can do for you. Ask for Jim Donovan, Jim Baird, Victor Takata or Dr. Joe Qualitz.

Material Handling

Importer



### ARTISAN INDUSTRIES INC.

73 Pond Street, Waltham, Mass. 02154 Telephone (617) 893-6800 • Telex 92-3312

Electronic leak detector and safety device.

			ARTISAN'S CONTRIBUTION	
CUSTOMER PRODUCT	PRODUCT	QUANTITY TO DATE	Total Manufacturing Responsibility	Special Services
Chemical Manufacturer	Textile Printing Equipment – Auxiliary	350	Yes	<ul> <li>Console and automatic controls for instruments, solenoid valves, steam, air, solvents, etc.</li> <li>Shipped direct to Customer's customers.</li> </ul>
Inventor & Consultant	Food Analyzer for Uniform Quality Control	240	Yes	<ul> <li>Re-designed to sanitary code and OSHA standards.</li> <li>Designed, improved, manufactured all electronic circuits.</li> <li>Marketing service – provided field service and parts back-up on a continuing basis.</li> </ul>
Bulk Chemical Producer	Expandable Poly- styrene Production Equipment for Pack- aging Use	380	Yes	<ul> <li>Research and development of concept – working with customer engineers.</li> <li>Designed machine to meet concept parameters.</li> <li>Motor controls and interlocks.</li> <li>Marketing service.</li> </ul>
Manufacturer	High Vacuum Coat- ing Equipment for Metallurgy Application	5	Yes	<ul> <li>Verification of stress calculations.</li> <li>Electrical controls and instrument wiring.</li> <li>Prototype microprocessor for increasing production and quality at reduced cost.</li> </ul>
Medical Team	Tissue Homogenizer for Medical Research	100	Yes	<ul> <li>ASME code, Sec. VIII, for 1500 psi design pressure (nitrogen containment).</li> </ul>
Machinery	Vacuum Lifters for	250	Yes	Low vacuum generating cylinder.